THE CONTEST WITH CONTEXT:

THEORY AND MILITARY INNOVATION

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14. ABSTRACT

This study investigates when and how military innovation occurs and what significant historical lessons can inform innovation in the United States Air Force. Theories that emphasize conflict relationships, culture, and structure are reviewed and four working hypotheses emerge. First, context matters most. Second, the organizations culture must tolerate debate and accept the challenge of change. Third, politically-adept, change-oriented leaders must emerge at multiple strata within the organization. Fourth, rigorous experimentation to solve problems and demonstrate the utility of the change is paramount. Two historical examples provide evidence for the analysis: the development of carrier aviation before the Second World War, in which the Royal Navy failed to innovate and the United States Navy succeeded, and the development of mechanized warfare during the same period, in which the British Army failed and the German Army succeeded. The study relies primarily on secondary source material. Analysis of the historical evidence supports the four working hypotheses. Further observations of significance include the importance of how the grand challenge is characterized in the outcome of an innovation; how the interwar debates about airpower both helped and hindered innovation; that evolutionary, combined-arms approaches appeared to be more successful; and that this type of change often required a generation or more before it was realized. Five key implications for the Air Force follow from the analysis. First, leaders must first be aware of and manipulate contextual factors when possible. Second, leaders must foster a culture that tolerates dissent. Third, leaders must identify and prepare other innovative leaders throughout the organization. Fourth, leaders must emplace a rigorous and systemic process for experimentation. Finally, personal professional, intellectual development must become a requirement of every officer. These implications suggest broad policy and process changes for the Air force, particularly in how it identifies, prepares, and selects leaders to innovate in the future and especially in how professional military education is designed and implemented to foster innovation and innovative thinkers within the ranks. The appendix contains a suggested self-study program for officers to use as a staring point for their personal study of warfare and military innovation.

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Any errors, omissions, or misconceptions in this paper rest solely on the author.

ABSTRACT

This study investigates when and how military innovation occurs and what significant historical lessons can inform innovation in the United States Air Force. Theories that emphasize conflict relationships, culture, and structure are reviewed and four working hypotheses emerge. First, context matters most. Second, the organization's culture must tolerate debate and accept the challenge of change. Third, politically-adept, change-oriented leaders must emerge at multiple strata within the organization. Fourth, rigorous experimentation to solve problems and demonstrate the utility of the change is paramount.

Two historical examples provide evidence for the analysis: the development of carrier aviation before the Second World War, in which the Royal Navy failed to innovate and the United States Navy succeeded, and the development of mechanized warfare during the same period, in which the British Army failed and the German Army succeeded. The study relies primarily on secondary source material.

Analysis of the historical evidence supports the four working hypotheses. Further observations of significance include the importance of how the grand challenge is characterized in the outcome of an innovation; how the interwar debates about airpower both helped and hindered innovation; that evolutionary, combined-arms approaches appeared to be more successful; and that this type of change often required a generation or more before it was realized.

Five key implications for the Air Force follow from the analysis. First, leaders must first be aware of and manipulate contextual factors when possible. Second, leaders must foster a culture that tolerates dissent. Third, leaders must identify and prepare other innovative leaders throughout the organization. Fourth, leaders must emplace a rigorous and systemic process for experimentation. Finally, personal professional, intellectual development must become a requirement of every officer.

These implications suggest broad policy and process changes for the Air force, particularly in how it identifies, prepares, and selects leaders to innovate in the future and especially in how professional military education is designed and implemented to foster innovation and innovative thinkers within the ranks.

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Chapter 1

Introduction

> *I am tempted to declare dogmatically that whatever doctrine the Armed Forces are working on now, they have got it wrong. I am also tempted to declare that it does not matter that they have got it wrong. What does matter is their capacity to get it right quickly when the moment arrives.*
>
> Sir Michael Howard, Chesney Memorial Gold Medal Lecture, 3 October 1973

If there is one sure thing regarding the future security environment, it is that warfare's constant companions – friction, chance, and uncertainty – will continue to profoundly affect outcomes. Michael Howard's quote expresses two significant themes: the difficulty of military innovation and the imperative of innovating to meet new realities. Despite wondrous advances in technology, indeed often because of them and the prospects for even greater technological change, the men and women who make decisions today about how we will fight in the future must do so facing enormous uncertainties and seemingly imponderable changes. Additionally, those who will fight in the future must adapt the organization, ideas, and equipment that earlier generations believed they would need to meet unforeseen circumstances.

Clearly, military professionals must harness innovation if they are to succeed. As historian Max Boot points out, militaries and even entire cultures have repeatedly "found themselves in the midst of a military revolution they did not understand – and all paid a heavy price for their backwardness."[1] Even the leading military powers of the period can find themselves left behind. Indeed, as Peter W. Singer points out in his book on robotics in war, in more than 4,000 years of warfare, the British Navy's transition from sail to steam is the only example of a military that stayed on top through a major revolution in warfighting.[2] This argument should be increasingly poignant for the United States,

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[1] Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York: Gotham Books, 2006), 7. Boot cites 16th century Italians, Sudanese warriors at the turn of the 19th century, French soldiers in 1940, and Iraqi soldiers in 1991 as examples.

[2] P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin Press, 2009), 239.

which has enjoyed dominance since 1945 and even more clearly since 1991. As Boot suggests, "The longer you are on top, the more natural it seems, and the less thinkable it is that anyone will displace you. Complacency can seep in, especially if, like the United States, you enjoy power without peer or precedent."[3]

The future security environment and the innovation challenge

The challenge of innovation proves even more daunting in today's security environment, considering the pace of technological advancement, a growing scientist-layman gap, budgetary turmoil, and the changing landscape of public and private research and development.[4] Emerging fields such as robotics, nanotechnology, and synthetic biology, among others, are not yet understood. All of these technologies are being developed in a world of increasing processing power and at a time when substantially greater numbers of scientists and engineers exist than at any other time in history. Moreover, many of these technologies are inherently dual-use, that is they could be used for commercial or military purposes, complicating the ability to monitor or control the spread of militarily significant technologies. The 9/11 attackers' use of commercial air carriers to conduct surprise attacks on a previously unmatched scale within the United States serves as the most recognizable example of this trend. Other examples include the use of cell phones to trigger improvised explosive devices in Iraq, or as a passive signal to identify and kill an individual terrorist.

Furthermore, the last decade has seen conflicting signals of whether the United States maintains the motivation and the ability to innovate that once characterized its approach to warfare. Some of these arguments address the changing landscape of research and development, public and private approaches and motivations, discontinuity between military and commercial needs, and basic competitiveness of U.S. education in the sciences and engineering.

Finally, globalization has seemingly eroded the importance of leading in innovation, as virtually anyone can become a fast follower. According to the National Intelligence Council's 2020 project, the world will continue to become increasingly

[3] Boot, 455.
[4] Tom Ehrhard, "Integrating Disruptive Technologies in DoD," briefing, Center for Strategic and Budgetary Assessments, 4 Sep 08, and personal interviews with the author on various dates.

globalized and less Westernized in the coming decade. An increasing number of global firms will facilitate the spread of new technologies. Moreover, the power of non-state actors will continue to increase, as will the weapons-of-mass-destruction capabilities of some states and possibly even terrorist groups. Finally, though the NIC expects the United States to remain the most powerful actor economically, technologically, and militarily, the council predicts the U.S. will lose its science and technology edge and face more frequent and open challenges to its position abroad.[5] The problem of military innovation in this new world is further complicated by our decision making structure.

The bureaucratic challenge

Military innovation is particularly affected by a bureaucratic structure – one in which individual hierarchical warfighting communities or services compete with each other for resources and influence. Within this structure, the organizational culture of a service, that is its rules, norms, values, and behaviors, can largely explain either success or failure to innovate. One bureaucratic barrier to innovation results from the inherent inflexibility of the planning, programming, budgeting process and the endemic uncertainty of tomorrow's security environment. Services are reluctant to gamble on future technologies when dollars are at stake. It is impossible to predict with 100 percent accuracy, for example, when a technology will mature sufficiently to allow a service to allocate funds to procure the system. At the same time, a research lab cannot afford to keep programs on life support until they make it into a service budget.

Dr. Tom Ehrhard describes a general service culture that is adverse to innovation unless the new weapon system or approach passes certain fundamental tests:

1. It solves an operational problem the service *prefers* to solve
2. It sustains a *familiar* form of warfare
3. It sustains the *dominant sub-cultures* within the Service[6]

This view, if even partly accurate, illustrates the difficulty of the task for any transformational leader within the defense establishment. Clearly, the services and the

[5] *Report of the National Intelligence Council's 2020 Project, executive summary* (Pittsburg: GPO, 2004), 9-18.

[6] Ehrhard, briefing, slide 7. Also see Singer, 254. Singer discusses "lock in," the idea that the combination of culture and past investment form a powerful barrier to innovation as services seek to keep old systems relevant and existing warfighting structures intact.

joint warfighting community writ large must come to grips with how a technology or new approach to an operational challenge will be addressed and implemented. This is a complex interaction between multiple stakeholders and diverse cultures – one that does not neatly run the course from new thing or idea to new concept for using it.

Harvard business professor Clayton Christensen describes this dilemma in terms of sustaining and disruptive innovation, where sustaining innovation aligns with an organization's existing processes and values and disruptive innovation challenges these processes and values in a new dimension.[7]

> The abilities of an established organization to do sustaining innovation become their disabilities to do a disruption. The biggest reason is that organizations are built to deliver sustaining innovations. The organization's values and processes – its DNA – are continually pushing it up one track. The problem is that an organization can't change those processes and values when disruption comes along.[8]

This is another way of describing the bureaucratic challenge to military innovation. Services pursue programs and policies that reinforce or sustain those missions and processes they already readily address – when core missions and processes are challenged, it can be very difficult for innovation to take hold.

Though a bureaucratic structure can sometimes hinder innovation, the existing structure may very well prove a necessary evil. The service role in standardizing processes, accomplishing big muscle movements, deploying forces, and maintaining and supporting forces and infrastructure is critically important to the United States' approach to national security. Confronting this dilemma, various authors have suggested techniques to overcome the bureaucratic barrier to innovation. These include "disguising" the innovation to protect it from opponents of the change, framing innovation as a threat to be better understood, or closely aligning the innovation with existing core missions.[9]

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[7] Christensen's theoretical construct will be addressed in more detail in chapter 2.
[8] "A Conversation With John W. Kenagy, M.D., M.P.A.: Time To Roll Out 'Disruptive Innovation,'" Managed *Care Magazine* (March 2001) [journal on-line]; available from http://managedcaremag.com/archives/0103/0103/qna_kenagy.html; Internet; accessed 13 November 2008.
[9] See "Rethinking Innovation: Disruptive Technology and Strategic Response," *Strategic Insights*, vol IV, issue 4 (April 2005), Center for Contemporary Conflict at Naval Postgraduate School; and Howard Dresner, "The Gartner Fellows Interview, Professor of Business Administration, Harvard Business School, Clayton M. Christensen, DBA, part 2," [on-line]; available from http://www.gartner.com/research/fellows/asset_94087_1176.jsp; Internet; accessed 13 November 2008.

The innovation imperative

Opponents and proponents of a particular military innovation are frequently cast into two distinct camps – technological determinists, who view history as the inevitable result of the development of particular machines or tools, and Luddites, who give short shrift to the advance of technology as a significant change agent in warfare.[10] These straw-man characterizations do not accurately capture the important issues at stake. Technology is not inherently good or evil. Warfighting has not been turned upside down, nor has it remained essentially unchanged over time. The essence of military innovation is tension, which historian Hal Winton vividly describes below:

> All human institutions must inevitably deal with the tension between continuity and change, between preserving that which has met the needs of the past and adapting to the challenge of change in a confusing present and uncertain future. This is true in politics, law, economics, and the arts; but this tension is particularly evident in military institutions in which tradition and the need for disciplined acceptance of authority in the chaos of battle vie with equally strong pressures to meet the demands of social transformation, and especially in the twentieth century, new means of waging war.[11]

Many observers assert that this tension manifests itself in a resistance to change, arguing that a "special kinship" with past warfighting generations and the value attributed to tested machines or methods of waging war make innovation difficult.[12] Another view suggests that these barriers ensure fundamental change is difficult, hoping to guarantee that the combat-tested means are not sacrificed for the illusion of progress. In short, the practitioner wants to ensure he can adapt to changes in the conduct of war, without over-reacting to trends and technologies that will not prove worthwhile.

If as the historical evidence suggests, innovation confers a distinct military advantage, then military officers seek to understand its dynamics. What factors most influence the outcome of innovation, either positively or negatively? How can individuals and organizations leverage these factors to their advantage? Fortunately, a diverse body of innovation literature seeks to answer just these types of questions.

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[10] Boot, 9.
[11] Harold R. Winton, "Introduction: On Military Change," *The Challenge of Change: Military Institutions and New Realities, 1918-1941*, edited by Harold R. Winton and David R. Mets, Lincoln: University of Nebraska Press, 2000, p. xi.
[12] Singer, 252.

However, even a cursory examination of innovation in the military or business reveals that the problem is not as simple as it appears. Different approaches or schools of thought regarding innovation provide contradictory interpretations and prescriptions, even in their analysis of the same historical cases. The next chapter briefly reviews the major strands of innovation theory and research. In chapter 3, I offer four working hypotheses from my research. Chapters 4 and 5 examine the working hypotheses against two historical case studies of carrier aviation and mechanized warfare.[13] Finally, chapter 6 offers four implications for the Air Force as it seeks to innovate in the future security environment.

[13] I will use the term mechanized warfare throughout this paper to describe what is commonly referred to as *Blitzkrieg*. The latter term, although widely used, has been roundly criticized by scholars, see Robert M. Citino, *Quest for Decisive Victory: From Stalemate to Blitzkrieg in Europe, 1899-1940* (Lawrence: University of Kansas Press, 2002), 181, and Karl-Heinz Frieser with John T. Greenwood, *The Blitzkrieg Legend: The 1940 Campaign in the West* (Annapolis: Naval Institute Press, 2005), 4-5, among others.

Chapter 2

Innovation Theory

> *America is at war – and war transforms armies. War does for armies what the marketplace does for business.*
>
> Douglas Macgregor in *Transformation Under Fire*[14]

The Merriam Webster Dictionary defines innovation as "the introduction of something new…a new idea, method, or device."[15] The introduction of a new aircraft tire fits this definition; but while the tire may yield important improvements in performance, this seemingly benign change does not satisfy the frequent thirst for "defense innovation." Supporting taxonomies seek to characterize the locus or impetus of change – top down, bottom-up, internally driven, externally driven, and so forth. Still others may break the problem into peacetime versus wartime innovation or characterize it as structural, doctrinal, technological, or even as architectural – an innovation that affects the underlying system architecture or links between the various components of a system.[16] These different categorizations add a great deal of richness to our understanding of innovation, but they also illustrate that innovation is colored not only by the case studies one chooses but also by the particular lens through which they are viewed. Innovation in many respects is in the eye of the beholder. Different observers of the same phenomenon often develop very different interpretations, one seeing the pace of change and adoption as too slow with the other seeing it as too rapid, for example.

Most theorists of military innovation concentrate on fundamental changes to the underlying technology, operating concepts, and structure of military forces, and often consider innovation incomplete without the presence of all three components.[17] It is this

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[14] Douglas Macgregor, *Transformation Under Fire: Revolutionizing How America Fights* (Westport: Praeger, 2003), 1.

[15] "Innovation," *Merriam Webster Online Dictionary*, [on-line]; Internet; available from http://www.merriam-webster.com/dictionary/innovation; accessed 13 February 2009.

[16] See Terry C. Pierce, *Warfighting and Disruptive Technologies: Disguising Innovation* (London: Frank Cass, 2004), p 15-17, for a discussion of architectural innovation.

[17] Dennis Showalter, "Military Innovation and the Whig Perspective of History," in *The Challenge of Change: Military Institutions and New realities, 1918-1941*, edited by Harold R. Winton and David R. Mets (Lincoln: University of Nebraska Press, 2000), 220; and Winton, xi-xii. It is also worth noting that the innovation need note be "new." As Col Jerome Lynes, USMC (ret) remarked in our interview, the re-introduction of "rediscovery" of extant thinking and approaches to Counter-insurgency operations or COIN

robust definition of innovation – often considered most apparent during the period between the two World Wars with the introduction of aircraft carriers and mechanized warfare – that dominates the debate and serves as the baseline for the argument presented here. This kind of innovation often manifests itself in changed relationships, either between belligerents or between the individual communities of practice that make up a military force. No definition is perfect; however I will borrow Stephen Rosen's definition of "major innovation" as a starting point:

> …a change that forces one of the primary combat arms of a service to change its concepts of operation and its relation to other combat arms, and to abandon or downgrade traditional missions. Such innovations involve a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas. They involve changes in the critical military tasks, the tasks around which warplans revolve.[18]

Different perspectives of innovation

Just as different definitions of innovation color our understanding, different ways of viewing particular cases will often result in different conclusions. It is easy to understand why businesses or management consultants study innovation – because innovative products, services, and operating concepts are required to generate profit and growth in order to keep a business viable over a long period of time. For this reason, business-related theories of innovation typically employ lenses that reveal essential factors about process or market or cost. Scholars and practitioners of military innovation hope to better understand the phenomenon in order to gain a competitive advantage in their business – warfare. Theories of military innovation are intended to explain when, why, and how military innovation occurs, and ultimately to provide some general guidelines for promoting innovation to gain a militarily-significant advantage. Several different perspectives or lenses for understanding innovation exist – each approaching the

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in recent years should also be considered innovative. The reintroduction of techniques that had fallen out of practice fundamentally changed current operations and helped to meet the challenges presented by ongoing operations in Afghanistan and Iraq.

[18] Stephen Peter Rosen, "New Ways of War: Understanding Military Innovation," *International Security* (Summer 1988): 134. Rosen's definition emphasizes conceptual or doctrinal change more so than technological change, though it can certainly accommodate the latter, particularly when a major technological breakthrough mandates changes to conceptual and organizational components of warfighting.

problem from a different angle and emphasizing different factors. The following sections briefly summarize some of these perspectives on how and when innovation comes about.

Conflict-relationships theories

Leading theorists within this school explain innovation through the lens of a key rivalry, either between civilian and military leaders, within services, or between services. Barry Posen characterizes a reluctant military, resistant to change, that relies upon civilian intervention and supporting military mavericks to bring about innovation.[19] According to Posen, civilians directly intervene to impose a new and disruptive vision of warfare upon the services when they perceive the security threat is high. In contrast, Stephen Rosen proposes an internally-driven model in which intra-service rivalry, that is the competition for resources and status between powerful branches within a service, yields innovation.[20] These insiders must challenge existing methods for waging war, refine a new method, and manage the political struggle that accompanies the innovation. The development of air defense in Britain before World War II provides the best contrast between these two theorists. Posen credits civilian defense minister Sir Thomas Inskip and maverick fighter advocate Air Chief Marshall Hugh Dowding with the reasoned opposition to the bomber-centric approach preferred by the Royal Air Force. Rosen counters by arguing that successive air chiefs, to include noted bomber man Hugh Trenchard, laid the groundwork for effective air defense that was "seized on and developed with great speed" after the introduction of radar.[21]

Owen Cote, on the other hand, asserts that innovation occurs when inter-service competition is high.[22] According to Cote, because power is more evenly shared between services than within a service, the dynamics of innovation are very different. Cote argues that inter-service competition can cause innovation or act as a catalyst to expedite

[19] See Barry Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars*. Ithaca: Cornell UP, 1984.
[20] Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, Ithaca: Cornell UP, 1991. Rosen also provides some interesting thoughts on technological innovation which is needed to help manage uncertainty. Uncertainty drives Rosen to argue for a strategy that develops a wide range of alternative technologies but stops short of procurement. This allows leaders to delay the determination which technologies should be pursued.
[21] Rosen, *Winning*, 16-18.
[22] See Owen Reid Cote, "The Politics of Innovative Military Doctrine," (Ph.D. diss., Massachusetts Institute of Technology, 1996).

innovation, especially when the fundamental beliefs or operating concepts of a service are threatened. Cote uses the inter-service conflict framework to explain the successive development of U.S. Air Force nuclear bombers, U.S. Navy Polaris nuclear missile submarines, and U.S. Air Force Intercontinental Ballistic Missiles.[23] Cote also contends that greater service cooperation after 1964 helps explain why the development of the Navy's Trident submarine was slowed – to avoid competition with the Air Force's development of the B-1 bomber.[24] According to Cote, this was, in turn, rewarded with the absence of Air Force opposition to plans for a 600 ship Navy.[25]

Though they differ in the specifics of the who, when, and how of innovation, each of these theorists sees conflict between powerful groups as the driver of military innovation and seeks to identify which relationships initiate and shape innovation more so than the others. They also suggest that manipulating the key conflict relationship affects the likelihood of success and the pace of innovation. Hybrid theories within this group, such as that proposed by Bradd Hayes and Douglas Smith, blend the intra- and inter-service approaches into a single framework in hopes of providing more explanatory power.[26] Hayes and Smith examine the development of the Tomahawk Land Attack Cruise Missile and the Aegis class destroyer, concluding that no one theory of innovation proved dominant and that both inter and intra-service competition stimulated innovation in these two cases.

Cultural theories

Elizabeth Kier, among others, rejects the conflict-relationship thesis and argues that culture better explains military innovation. According to Kier, culture profoundly shapes the thinking of military leaders and therefore can enable or inhibit certain innovations. Keir cites the example of mechanized warfare in the interwar period as a prime example, showing that cultural factors drove different outcomes in Britain, France, and Germany, despite shared experience in WWI and similar technology.[27]

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[23] Ibid., 345.
[24] Ibid., 348.
[25] Ibid.
[26] Bradd C. Hayes and Douglas V. Smith, eds., "The Politics of Naval Innovation," Research Report 4-94. (Newport, RI: U.S. Naval War College, 1994), 97.
[27] Elizabeth Kier, *Imaging in War: French and British Military Doctrine between the Wars* (Princeton: Princeton UP, 1997).

For example, Kier argues that French domestic political and military cultures in the 1920s and 1930s prevented effective measures that would have countered the defeat of 1940.[28] Critics, however, assert French decisions accurately reflected the European balance of power and the military realities of the day, insisting that the defeat of 1940 rested more squarely on inept planning, poor assumptions, and less than optimum placement of forces.[29] Like the conflict relationship theories presented above, the use of specific cultural explanations for innovation is neither right nor wrong. The real question is how do cultural theories blend with other approaches to best explain innovation?[30]

An important subordinate concept, particularly in light of the bureaucratic make-up of most national militaries is organizational culture. In his work on the subject, *Organizational Culture and Leadership* (1985), Edgar Schein describes three levels of organizational culture (artifacts and behaviors, espoused values, and underlying assumptions) that shape the way individuals interact with others, both internal and external to the organization.[31] For example, organizational culture helps explain how the Japanese auto maker Toyota seems to be much more innovative and efficient than rival auto manufacturers like General Motors: "This culture, known as 'The Toyota Way,' is hard to reproduce, perhaps because it uniquely emerges from the company's roots in a particular place, Toyota City. A core element of that winning culture seems to be the willingness of all workers to push themselves beyond where they feel comfortable—*kaizen* in action."[32] The idea that a peculiar organizational culture can affect the rate and

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[28] Kier, 56-88.

[29] Michael C. Desch, "Culture Clash: Assessing the Importance of Ideas in Security Studies," *International Security* 23, no. 1 (Summer 1998), p. 161-2.

[30] In his analysis, Desch asserts that culturalists "claim too much for cultural explanations," yet they prove unable to supplant existing approaches to security studies. See Desch, 169-70.

[31] See Edgar A. Schein, *Organizational Culture and Leadership*, San Francisco: Jossey-Bass Publishers, 1985.

[32] "The car company in front – Toyota," *The Economist* 374 (29 Jan 95): 73. The Japanese word *kaizen* is equivalent to the English concept of "continuous improvement." Similarly, recent research suggests that the top performing US companies between 1980 and 2000 (Southwest Airlines, Wal-Mart, Tyson Foods, Circuit City, and Plenum Publishing) triumphed despite the fact that they did not enjoy the key market advantages and conditions that scholars noted as pre-requisite for success. In all five cases, organizational culture was cited as providing the competitive advantage. See Kim S. Cameron and Robert E. Quinn, *Diagnosing and Changing Organizational Culture based on The Competing Values Framework* (Upper Saddle River, NJ: Prentice-Hall, 1999), 4. First chapter retrieved online from http://webuser.bus.umich.edu/cameronk/CULTURE%20BOOK-CHAPTER%201.pdf on 13 Feb 09. Interestingly, Circuit City has recently declared bankruptcy, suggesting that the ability to innovate does not confer a lasting advantage in a competitive environment.

overall progress of innovation is a vital element within existing theories, like those offered by Posen and Rosen.

Structural Theories

Another strain of innovation theory argues that structural factors determine success or failure. Though not explicitly a structural theory, Clayton Christensen's analysis of successive waves of innovation in the computer disk drive industry provides an example here.[33] Christensen observed that the vast majority of innovations offered improved product performance along traditionally valued domains, such as increased storage capacity. He classified this type of innovation as sustaining and noted that industry leading firms typically remained on top with the introduction of sustaining innovations, even if they were not the first entrant. A second more rare type of innovation, which Christensen classified as disruptive, promised lower performance in a valued domain. However, the disruptive innovation changed the value proposition of the product, resulting in new patterns of use and new customers. Christensen noted that the disruptive innovation also underwent waves of sustaining innovation to improve its performance until it eventually overtook the market. Interestingly, he observed that industry leaders almost never survived the introduction of a disruptive innovation. For example, Digital Equipment Corporation, once the leading computer manufacturer, did not survive the introduction of the personal computer. This observation neatly parallels Max Boot's observation that leading militaries often fail to survive the advent of a disruptive way of war.

Confronting this dilemma, Christensen's argued that certain market conditions and organizational phenomena prevent an industry leader from undertaking a disruptive innovation. For example, when large, established businesses evaluate the potential of disruptive products, they often find the profit margins and market share too insignificant to invest significant resources or effort in developing the product – and they often don't understand the future potential because they focus market research on existing customers

[33] The foundation of Disruptive Innovation theory, or DI as it is sometimes referred to as, is found in the following works: Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, (Cambridge: Harvard Business School Press, 1997) and Clayton Christensen and Michael Raynor, *The Innovator's Solution: Creating and Sustaining Successful Growth*, (Cambridge: Harvard Business School Press, 2003).

in traditional market segments. Furthermore, similar conditions made it difficult to adapt once a competitor had introduced the disruptive product or process. In fact, Christiansen argued that the same sound business and management practices that allowed the company to succeed in the face of sustaining innovation, contributed to its failure when faced with disruptive innovation. Success at disruptive innovation typically required a completely autonomous business unit to develop the disruptive technology and to compete against the parent company in the marketplace, as IBM did with the mini-computer or Hewlett-Packard did with the ink jet printer.[34]

The Defense Advanced Research Projects Agency (DARPA) serves as an example of this rule.[35] The idea that small focused teams are best at innovation also suggests that bureaucracies, like the Department of Defense writ large or individual services will not perform in innovative ways due to the inherent weaknesses of their structure.[36] DARPA is not alone within the department – service warfighting laboratories, other offices and agencies like the DoD Rapid Prototyping Office, and even a significant portion of an the Joint Forces Command, are organized, staffed, and

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[34] Howard Dresner, "The Gartner Fellows Interview, Professor of Business Administration, Harvard Business School, Clayton M. Christensen, DBA, part 2," [on-line]; available from http://www.gartner.com/research/fellows/asset_93329_1176.jsp; Internet; accessed 13 November 2008. Other research suggests that structure does not play a key role in fostering innovation; for example, see Deborah Dougherty and Cynthia Hardy, "Sustained Product Innovation in Large, Mature Organizations: Overcoming Innovation-to-Organization Problems, Academy of Management Journal 1120 (Oct 1996), which argues that innovation occurs in spite of an organization's structures, not because of them.

[35] DARPA has earned a well-deserved reputation for pioneering innovation in government. This is due to a variety of factors, from personnel policy to structure to resources. Also see Francis Fukuyama, *Blindside: How to Anticipate Forcing Events and Wild Cards in Global Politics*, Washington, D.C.: Brookings Institution Press, 2007, p. 57-70. William Bonvillian's chapter on DARPA in *Blindside* provides a brief but excellent summary of the organization's history and approach. Bonvillian paints a picture of a small, flexible, flat organization, freed from bureaucratic impediments, that brings a wide range of talent together to solve tough operational challenges – often characterized as "DARPA tough." DARPA connects researchers in academia, industry, and government who then collaborate to solve a particular challenge under the watchful eye of the DARPA program manager and the Director. They also attack challenges creatively, even offering prize money, for example, for wearable power innovations or for a vehicle that can autonomously navigate a road course.

[36] As an example, see "Google's view on the future of business: An interview with CEO Eric Schmidt," *The McKinsey Quarterly*, September 08 [on-line]; available from http://www.mckinseyquarterly.com/article_print.aspx?L2=21&L3=35&ar=2229; Internet; accessed 13 November 2008. "Innovation has always been driven by a person or a small team that has the luxury of thinking of a new idea and pursuing it. There are no counter examples… Innovation is something that comes when you're not under the gun. So it's important that, even if you don't have balance in your life, you have some time for reflection…we try to encourage [innovation] with things like 20 percent time, and the small technology teams, which are undirected… Google's objective is to be a systematic innovator at scale…We don't know this month which one (of our groups will succeed]. But we know it's portfolio theory. We have enough groups that a few [innovations] will pop up."

chartered to promote innovative approaches to warfighting. At the end of the day, perhaps the biggest challenge facing a DARPA project manager (or another defense innovator) is the handoff of a promising technology innovation or idea to a service bureaucracy.[37]

Historical approaches

The theories above represent primarily a political-science approach to the problem of military innovation. It should not come as a surprise that military historians such as Max Boot, Williamson Murray, and Harold Winton, have also sought to shine a light on innovation in warfare. Within this genre, there are any number of excellent case studies and treatments of innovation. Often considered the most illuminating are the development of carrier aviation and mechanized warfare in the interwar period; however a wide variety of modern innovations also deserve notice, such as Global Positioning System (GPS), Precision Guided Munitions (PGMs), Inter-Continental Ballistic Missiles (ICBMs), Air-Land Battle, and so on. A couple considerations regarding case selection should be mentioned. First, carrier aviation in particular represents an American success on a grand scale – for this reason it may shed some light on peculiar lessons for innovation in the American military. It is also noteworthy that in both carrier aviation and mechanized warfare, the British enjoyed the lead at the end of World War I. In both cases, however, other powers achieved success ahead of the Brits, making a comparative study of British attempts particularly interesting.

However, as noted by Murray, historians in general have proved more reluctant to provide prescriptions for future behavior, preferring instead to illuminate the circumstances of particular cases.[38] Despite Murray's skeptical assessment, the sum of

[37] See, Ehrhard, briefing, slide 14: "As technologies mature, Service integration becomes just as important as technical details"

[38] Murray's observation, in a more controversial form, appears in the forward to Colin Gray, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History* (London: Frank Cass, 2002): "One might best sum up the prevailing attitudes in the historical profession in the following terms: 'Generalize or suggest larger patterns of behavior? My goodness, we certainly wouldn't want to do that, would we?' Thus most works on military or strategic history focus on the specific with little willingness – or interest – to generalize, much less theorize, about larger issues and patterns of war throughout the ages… [historians] have been all too unwilling to engage in the great defense debates that swirl around Washington's Beltway or even within the larger defense community. Political scientists on the other hand, have been all too willing to theorize without coming to grips with the harsh complexities of historical research or of the alien world – at least to many of them – of real facts."

these efforts can reveal common threads among cases which help to illuminate the problem as well as the solution. For example, the peculiar context surrounding each innovation effort as well as the key role of one or two central figures seems to play prominently in most historical studies. Moreover, both the development of carrier aviation in the United States and Japan as well as the development of mechanized warfare in Germany between the two World Wars highlight the importance of experimentation.

Summary

The brief summary of innovation theory presented above is not meant to trivialize or over-simplify the arguments of each particular theorist. Indeed, each individual approach can help explain the dynamics of a particular case and provide some general lessons for the student and practitioner alike. In their totality, they show that innovation comes about through a series of complex interactions at multiple levels both internal and external to an organization, and that a variety of factors or conditions can either promote or hinder the process.

Chapter 3

Working Hypotheses

> *From one perspective, it might seem that in warfare, as in many other realms, change is slow and gradual: that it is characterized, in other words, by a process of continual evolution, not by a few wrenching revolutions. This is to some extent true; we must not pretend that change was more sudden or sweeping than it actually was, or unduly emphasize novelty at the expense of continuity, which is always considerable. But in the military sphere, just as in science, economics, art, or culture, change is not evenly distributed across space and time. Sometimes innovations cluster together to produce a major change in the way people live – or in the case of the military, the way the die.*
>
> Max Boot, in *War Made New*[39]

Over the course of the last six months, I have had the opportunity to read and reflect on the body of work on military innovation. I have also had the good fortune to talk about innovation with a wide variety of individuals, in academia, think tanks, government, and business. Each one of the models presented in the previous chapter helps shed some light on innovation, but no single model enjoys an advantage in explanatory power across different contexts or through multiple cases. From my research, four working hypotheses emerge.

First, context matters most. Although hindsight often allows us to construct plausible explanations for success or failure of a particular innovation, the circumstances of each individual case are so unique – the relationships and interactions between many people at multiple levels so complex – that the search for an explanatory theory or a checklist of steps to follow is folly. Historian Dennis Showalter's first rule from his study was "change in military affairs is contextual."[40] Economic conditions, geography, political realities, personal affinity for a particular individual or set of ideas, the general outlook and disposition of a population to technology or a particular worldview, the location of an individual factory or military base – these and myriad other conditions

[39] Boot, 7-8.
[40] Dennis Showalter, "Military Innovation and the Whig Perspective of History," in *The Challenge of Change: Military Institutions and New realities, 1918-1941*, edited by Harold R. Winton and David R. Mets (Lincoln: University of Nebraska Press, 2000), 229.

affect the outcome of any attempt to innovate. Furthermore, these conditions interact within widely differentiated systems, producing very different results from one military to another – indeed from one service to another or in the same service at different times.

Second, the organization's culture must tolerate debate and accept the challenge of change. The idea of an innovative culture has clearly grabbed a lot of attention in business literature, with companies like Google, 3M, and General Electric recognized for their ability to adapt or remake portions of their business to meet new demands. It is often suggested that hierarchical bureaucracies such as military services are incapable of renewing themselves in this same manner. However, innovation clearly occurs despite these structural limitations. More than structure, a favorable organizational culture profoundly influences the propensity to innovate.[41]

A supportive innovation culture protects subordinates' rights to dissent, encourages experimentation and risk taking, and is buttressed by leaders who not only talk about innovation but expect and measure it.[42] Moreover, research indicates that creative people are "unlikely to be drawn to corporate environments that do not protect their ability to dissent and view problems differently from other workers."[43] Leading corporate and government consulting firm McKinsey and Company includes these kind of conditions as a core part of organizational health. McKinsey's research suggests that companies fail to achieve sustained excellence precisely because they focus squarely on performance indicators instead of health indicators.[44] For McKinsey, renewal, or the ability of an organization to adapt to new realities and remake itself to compete more

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[41] Richard Elder I, Director, McKinsey & Company, Washington, D.C., personal interview with the author, 22 January 2009. In practice, structure proves less determinant of innovative behavior than most people believe. According to Elder, "structure is blunt…it never works by itself…. Innovation can take place in almost any structure given the right processes, culture, and knowledge sharing capacity."

[42] See Anurag Sharma, "Central Dilemmas of Managing Innovation in Large Firms," *California Management Review* 41/3 (Spring 1999): 147-164.; Susanne G. Scott and Reginald A. Bruce, "Determinants of Innovative Behavior: A Path Model of Individual Innovation in the Workplace," *Academy of Management Journal* 37/3 (Jun 1994): 580-607; "What Makes a Company Innovative," Corporate Innovation Forum, 8 March 2006 [on-line]; available from http://www.managementlogs.com/2006/03/what-makes-company-innovative.html; Internet; accessed 13 February 2009; and Michael Schrage, "Create the Right Environment to Foster Innovation," 15 Nov 2005, CIO online, [on-line]; available from http://www.cio.com/article/print/14307; Internet; accessed 13 February 2009.

[43] Charlan Jeanne Nemeth, "Managing Innovation: When Less is More," *California Management Review* 40/1 (Fall 97): 59-74.

[44] "Organizational Health Index: The Missing Management Metric," McKinsey & Co. briefing, January 2009, slide 3.

effectively, is made up of three components: leadership, external orientation, and innovation.[45]

When discussing the role of culture in innovation, Christopher Gehler asserts that "Organizations favor policies that reinforce the essence of the organization and that provide a clear roadmap to success for its members."[46] This means that services and powerful sub-groups view innovation through a peculiar lens and will respond to change in ways that satisfies established value propositions within their group. Furthermore, the accumulation of policies and procedures over time helps to solidify the place of common group interests and approaches. Allowing innovation to flourish then often requires leaders who encourage and protect it and spend their time actively driving it.[47]

Third, politically-adept, change-oriented leaders must emerge at multiple strata within the organization. In his survey of revolutions in warfare, historian Max Boot borrowed the following observation from noted political scientist James Q. Wilson:

> Not only do innovations differ so greatly in character that trying to find one theory to explain them all is like trying to find one medical theory to explain all diseases, *but innovations are so heavily dependent on executive interests and beliefs as to make the chance appearance of a change-oriented personality enormously important in explaining change*. It is not easy to build a useful social science theory out of "chance appearances."[48]

This observation suggests that a powerful, high-level leader can have enormous impact on the development and ultimate success or failure of an innovation. However, Wilson's observation also illuminates a peculiarly American penchant to attribute great things to the singularly distinctive accomplishments of a great man. This debate has captured imaginations since Thomas Carlyle and Ralph Waldo Emerson provided opposing viewpoints on the subject in the middle of the nineteenth century.[49] Moreover, this belief

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[45] Ibid., slide 5.
[46] Christopher Gehler, "Agile Leaders, Agile Institutions: Educating Adaptive and Innovative Leaders for Today and Tomorrow," (Carlisle: Strategic Studies Institute, 2005), 4.
[47] Joanna Barsh, Marla M. Capozzi, and Jonathan Davidson, "Leadership and Innovation," The McKinsey Quarterly (January 2008) [on-line]; available from http://www.mckinseyquarterly.com/article_print.aspx?L2=21&L3=35&ar=2089; Internet; accessed 26 January 2009.
[48] Boot, 457.
[49] Thomas Carlyle's *On Heroes, Hero Worship and the Heroic in History* (1841) offered the great man thesis with the words, "Universal History, the history of what man has accomplished in this world, is at bottom the History of the Great Men who have worked here." In response, Ralph Waldo Emerson penned *Representative Men* (1850), suggesting that the iconic men of each age enjoyed common qualities with many, that they are in fact models or exemplars of the age and not giants among the many.

endures, as demonstrated by our perception of the power and prestige of Presidents, captains of industry, sports heroes, and in the military, generals and admirals.[50]

Even if they are not of supreme importance to the problem, able, change-oriented leaders do bring an important skill set to the table when promoting innovation:

> John Law, in describing Portuguese attempts to master navigation along the African coast in the 15th century, coins the term 'heterogeneous engineering…In Law's parlance, every technical system faces associative and dissociative forces. The heterogeneous engineer takes advantage of the associative forces to overcome the dissociative ones in bringing the system to closure, or a stable form.[51]

More simply put, a change-oriented leader must survey the landscape to better understand the obstacles and the resources or positions of leverage that stand between him and his vision of warfare. He must then apply his efforts to remove or minimize barriers and enhance his leverage. Furthermore, the leader's involvement in understanding the environment and promoting innovation must be very personal. Because an organization is optimized for the old way of doing business, its processes and sources of information may not adequately capture those things that are most important to the new vision.[52]

Historian Hal Winton suggests several hypothetical qualities for the military leader who recognizes the need for change: "1) intelligence and intuition that accurately defines a future need and relates the reform to that need; 2) quiet, steely determination; 3) ability to promote adherents, convert fence-sitters, and neutralize opponents; 4) capacity to reach out to external constituencies for support."[53] I would also suggest that the leader needs to understand what kind of innovation is appropriate to the situation.[54]

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[50] In football, for example, the quarterback is often saddled with a disproportionate credit for a victory or a defeat. Similarly, the President of the United States is seen as pivotal to policy outcomes, despite the fact that congress, the courts, the public, other governments, the individual bureaucracies that implement policies, and a host of other people and groups profoundly affect the result.

[51] Stephen Chiabotti, "Heterogeneous Engineering and JPATS: Leadership, Logic, and Acquisition Requirements," unpublished manuscript, 1. Also see John Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., *The Social Construction of Technological Systems* (Cambridge: MIT Press, 1987).

[52] Joseph L. Bower and Clayton M. Christensen, "Disruptive Technologies: Catching the Wave," *Harvard Business Review* (Jan-Feb 1995): 43-55. "To avoid allowing small, pioneering companies to dominate new markets, executives must personally monitor the available intelligence on the progress of pioneering companies through monthly meetings with technologists, academics, venture capitalists, and other nontraditional sources of information. They cannot rely on the company's traditional channels for gauging markets because those channels were not designed for that purpose."

[53] Harold Winton, School of Advanced Air and Space Studies, electronic interview with the author, 5 December 2008. Winton also suggests some possible methods for winning over more adherents, including

Change-oriented leaders get credit for the success of many innovative leaders in different strata throughout the organization. Often a guiding coalition or a confederation of leaders in positions of influence shapes the ultimate outcome.[55] This group of innovators may operate outside the normal hierarchy, requiring powerful leaders to protect it from internal opposition.[56] These innovators are also supported by individuals and teams who solve the key tactical and operational challenges that threaten the innovation.[57] Throughout this process, the utility of these new concepts must be proven before the "finesse and sheer grit" of the people at the top can secure the acceptance of a new technology or approach to warfighting.[58]

Finally, rigorous experimentation to solve problems and demonstrate the utility of the change is paramount. Warfare is complex – friction, chance, and uncertainty dominate outcomes. Perhaps even more important, any new tool or conceptual approach to warfighting must be integrated with existing components. New things and new ideas always face a series of tactical and operational challenges that must be overcome during the course of their development. While much of this work can be done through different types of simulation, wargaming, and modeling, the last hurdle – demonstration of the utility of the new equipment or method to the skeptic often requires robust and repeated experimentation. Barry Posen, though doubtful of the ability of military organizations to innovate from within, does acknowledge that militaries' do learn from wars fought by their client states, their own wars, and especially from defeat.[59] In this way, actual combat experience can more effectively substitute for peacetime experimentation.

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manipulation of the institutional reward system, conversion of the professional education system, and use of professional and relevant external journals.

[54] Elder I. For example, Walmart's innovations tend to focus on the supply chain while Apple Computers focuses on the market and latent demand (no one needed another phone, but the iPhone was easy to use and leveraged new functionality). A military example might be using a new navigational tool (like GPS) to allow a single aircraft and a single bomb to do the work of many.

[55] John P. Kotter, "Leading Change: Why Transformation Efforts Fail," *Harvard Business Review* 73 (Mar 95): 59-68. The author provides several lessons from watching more than 100 companies try to remake themselves over a decade long period. Kotter asserts that failure to build a strong enough guiding coalition can often result in the failure of an innovation. The coalition must also a simple yet powerful vision of the future in which the innovation will prosper, according to Kotter.

[56] Ibid.

[57] Hayes, 4, 10. Hayes and Douglas cite research that innovation results from the "persistent efforts of mid-grade officers."

[58] Chiabotti, "Heterogenius Engineering," 1.

[59] Posen, 54-7.

If accurate, these four hypotheses yield several broad implications for military forces. In the next two chapters, I will examine these hypotheses against historical evidence. The analysis will focus on the development of carrier aviation before World War II and the development of mechanized warfare during the same period. These two case were chosen as critical case studies for the purposes of this paper.[60] Both cases prove significant due to their scope, the incorporation of both technological and conceptual innovation, and their sheer impact on warfare after the innovation. Furthermore, the cases are the dominant cases in the extant research on military innovation. Certainly, a number of different cases could have been selected to yield useful insights on military innovation.

[60] For a discussion of the use of case studies see, Bent Flyvbjerg, "Five Misunderstandings About Case-Study Research," *Qualitative Inquiry* 12/2 (April 2006): 219-245.

Chapter 4

The Development of Carrier Aviation[61]

> *[The Navy regards] aviation and its future as a component part of the fighting Navy; that aviation will be…a regular part of the Navy; that the men who are in aviation…will finally get to commanding ships and commanding fleets…*
>
> Admiral Robert Coontz, Chief of Naval Operations, 1921

Great Britain

The early leaders in the race to develop carrier aviation, by the outbreak of the Second World War the British had taken a backseat to both the United States and the Japanese in the technological and intellectual development of the naval air arm.[62] "While the British had more carriers built and building than any other navy, many of them were the obsolete results of early pioneering days."[63] Additionally, the British possessed less than half the front-line aircraft than either the Americans or the Japanese, and many of these were multi-purpose aircraft which could not match the performance of their counterparts.[64] These conditions stymied the development of a more robust doctrine and role for carrier airpower, relegating the arm to ancillary status.[65]

Several plausible explanations for these failings exist, from the "pigheaded conservatism of an Admiralty obsessed by the power of the battleship" to the "emasculation of the Navy on April 1, 1918" when much of the naval air arm, and

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[61] For a discussion of historical inquiry and its role in the preparation of military professionals, see Antulio Echevarria II, "The Trouble with History," *Parameters* (Summer 2005): 78-90. Echevarria describes the strengths and weaknesses of historical analysis and concludes that while imperfect, the study of the past is important for developing critical thinking skills and a broad understanding of how warfare has developed.

[62] Geoffrey Till, *Air Power and the Royal Navy, 1914-1945, A Historical Survey* (London: Jane's Publishing Company, 1979), 187. This paper discusses the development of naval aviation in Great Britain and the United States. During this period, Japan arguably outperformed both of these rivals in this area. For a look at the Japanese case, see Mark Peattie and David Evans, *Kaigun: Strategy, Tactics and Technology in the Imperial Japanese Navy, 1887–1941* (Annapolis: Naval Institute Press, 1997) and Mark Peattie, *Sunburst: The Rise of Japanese Naval Air Power, 1909–1941* (Annapolis: Naval Institute Press, 2001).

[63] Ibid. Also see Clark G. Reynolds, *The Fast Carriers: The Forging of an Air Navy* (Annapolis: Naval Institute Press, 1968), 2-4. The British actually invented the aircraft carrier after the Battle of Jutland in 1916, fielding two crude ships by the end of the war and another three in the interwar period. Her first modern fast carrier, the 30-knot, 60-airplane *Ark Royal* was completed in 1938.

[64] Ibid., 187.

[65] Ibid.

especially it's intellectual and institutional leadership, was handed over to the Royal Air Force (RAF).[66] Of these explanations, the inter-service competition for resources and influence has cast a long shadow over the issue. In fact, the Fleet Air Arm, or FAA, became a pawn in a larger competition between the Royal Navy (RN) and the RAF – one in which the "resolution of the most inconsequential of issues could easily require Herculean efforts."[67] The fact that it is impossible to clearly mark the boundary between airpower and seapower, in both theory and practice, only made matters worse.

Leadership and influence of the naval air arm proved insufficient, primarily due to transfer of the force to the RAF in 1918.[68] During the period, naval aviation was treated almost as an afterthought, with land-based strategic bomber forces enjoying the resources and interest of the defense establishment.[69] Influence within the RN had ebbed as well; throughout the 1920s, a "lowly captain" led the small Naval Air Section in the Admiralty.[70] Though the Royal Navy successfully repatriated fleet air in 1937, "the changeover took two time-consuming years to complete."[71]

Geoffrey Till's balanced account of the period, however, goes beyond these surface symptoms to illuminate the essence of the British failure. First, the dire British economic situation between the wars forced the government to make hard strategic choices. The Royal Navy, traditionally the recipient of the largest portion of defense expenditures, was particularly hard hit by the belt tightening.[72] Overall "economic stringency" left scraps for the FAA when the RAF and the RN prioritized their spending.[73] Indeed, Till points out that an almost "tacit alliance" between the Treasury and the Air Ministry limited the growth of naval air resources.[74] Second, industrial

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[66] Ibid., 189. Till also recounts the argument that a series of technical misjudgments undervalued the performance of airpower.
[67] Ibid., 192. Certainly a broad and often acrimonious debate arose between the two services on the nature of war, the respective roles of air and sea power, and perhaps most importantly their relative importance to the defense of the home islands and the empire. Till also highlights the competition within the RN over the relative importance of aircraft versus "guns," the leading community of practice in a battleship dominated navy.
[68] Reynolds, 2.
[69] Ibid.
[70] Ibid.
[71] Ibid.
[72] Till, 198-201.
[73] Ibid., 190-2.
[74] Ibid., 191-2.

capacity, research and development, and experimentation were all severely affected by the economic shortfalls.

Third, the characterization of the challenge facing Britain reinforced these tough decisions. By the late 1930s and into early 1940, the German threat grew not only in numbers, but also in stature. British politicians, military leaders, and the general public were "haunted by nightmare visions of a massive 'knock-out blow' from the air."[75] As John Ray points out, the danger "of German aerial attack which prevailed in Great Britain throughout the 1930s was overestimated."[76] Regardless of the facts in retrospect, the English Channel did not appear to be a substantial barrier to rising German militarism, especially given the apparent efficacy of the *Luftwaffe*. "The close waters of the European continent legislated against carrier development more than any other factor. Close waters favored land based aviation, and they knew it. Additionally, by the mid-1920s the Pacific was a secondary concern to the Brits."[77]

Great Britain faced a difficult dilemma. "Her economic limits required Britain to concentrate her efforts, but her strategic circumstances seemed to make this virtually impossible."[78] Both the Admiralty and the Air Ministry had valid cases for their preferred approach to the strategic problems they faced. British policy makers chose to concentrate on the German threat to the homeland – a choice driven in large part by geography. To meet the demand for air superiority over the home islands, half of the island nation's war production was devoted to the RAF in May 1940.[79] In the end, limited economic and industrial possibilities coupled with dire strategic choices drove the lackluster development of carrier aviation in Britain between the wars, not the vociferous battles between the air and sea services.[80]

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[75] Richard Overy, *Battle of Britain: The Myth and the Reality* (New York: W.W. Norton, 2000), 3-5.
[76] John Ray, *The Battle of Britain: Dowding and the First Victory, 1940* (London: Cassell, 1994), 33. Ray's comparison of intelligence estimates during the period reveal German "capabilities and intentions" that differ markedly from what was generally believed in Britain. Also see Overy's discussion in chapter 1 of his work.
[77] Stephen Chiabotti, School of Advanced Air and Space Studies, electronic interview with the author, 10 February 2009.
[78] Till, 198-9.
[79] Ibid., 200-1.
[80] Ibid.

The United States

In contrast, despite sharing similar pre-war experiences with the British, American naval aviation developed differently during this period – why? First, despite the effects of the Great Depression, the US economic situation did not prove as dire as that of Great Britain. However, the economic conditions proved substantial enough that the period must be viewed as one of cautious restraint, requiring creative approaches to innovation. For example, just as the British had to restrain their experimentation, the U.S. Navy "spent most of the interwar period in port.... The prohibitive cost of fuel and ammunition limited major training opportunities to annual periods of 'fleet concentration.'"[81] As we will see later, these annual large-force exercises proved pivotal to the development of carrier aviation and its growth within the navy.

As in the British case, geography and strategic realities also played an important role. Although it enjoyed a substantial empire after the turn of the twentieth century, U.S. territorial possessions remained much less far-flung than those of the British Empire. Moreover, the physical separation of the United States from continental concerns continued to shape policy and perceptions. Perhaps most importantly for this case, the United States Navy very early and very clearly defined the strategic challenge – the imperative of crossing the broad Pacific Ocean in wartime.[82] It is clear that from the time of the Washington Naval conferences through the outbreak of the Second World War that the United States Navy and American strategists in general regarded Japan as the next likely adversary.[83] By 1922, American naval strength had shifted from the Atlantic to the Pacific, and the problem of operations in that vast ocean dominated interwar thinking.[84] With the context established, let's turn to the personal interactions that made a difference.

Perhaps the most unlikely of heroes proved key to the growth of carrier aviation – US Army Air Service Brigadier General William "Billy" Mitchell. Mitchell passionately preached the need for an independent Air Force to be created from the aviation assets of

[81] Craig C. Felker, *Testing American Sea Power: U.S. Navy Strategic Exercises, 1923-1940* (College Station: Texas A& M UP, 2007), 147.
[82] Reynolds, 14.
[83] Ibid., 17.
[84] Ibid.

the Army and the Navy.[85] Mitchell's very public protestations probably did more to sway internal as well as external opponents of carrier air, to include then Chief of Naval Operations (CNO) Admiral William S. Benson.[86] Admiral Benson "felt that naval air should be administered at a very low level," but raised aviation to bureau status in hope of silencing Mitchell and like-minded critics.[87] Mitchell's demonstration of the vulnerability of a battleship to attack from the air further aided the growth of the naval air arm.[88] Mitchell's public crusade following the crash of a naval dirigible in 1925, not only led to his court-martial, but also to direct congressional involvement:

> Congressional legislation resulted from the Morrow Report in 1926 and set the course for naval and particularly carrier air for the next fifteen years. Along with calling for more naval aircraft, this legislation accomplished two major reforms. First, it established the Office of the Secretary of the Navy (Aeronautics), giving naval aviation representation at the top civilian level… Second, the legislation ruled that all commanding officers of aircraft carriers, seaplane tenders, and naval air stations be qualified aviators.[89]

Ultimately, Mitchell's outspokenness caused the navy to circle the wagons, ending any real threat to carrier aviation from within the service, and it led congressional supporters to insulate it from the outside threat. For all his showmanship however, Mitchell was not the only hero of this story.

Leadership within the U.S. Navy fortuitously fell upon Admiral William A. Moffett. The first Chief of the Bureau of Aeronautics, or BuAer, Moffett proved an able administrator and adept political actor.[90] Felker suggests that Moffett's strategy was "to

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[85] Ibid., 14. Also see David E. Johnson, *Fast Tanks and Heavy Bombers: Innovation in the U.S. Army, 1917-1945* (Ithaca: Cornell UP, 1998): 61.
[86] Ibid. Also see Felker, 36-42.
[87] Ibid., 14-15.
[88] Reynolds, 14, and Felker 39-40. The significance of the sinking of German battleship *Ostfriesland* and several other ships off the Virginia Capes by air-delivered ordnance was at the time, and to some extent remains, a subject of intense debate. After 2 days and 19 direct hits on the unmanned and immobile craft, the ship succumbed. Despite the degree of inconclusiveness, airmen had obliterated the myth of invincibility of the capital ship; but Mitchell's crusade also caused the navy's old guard to circle the wagons with their air-minded fellow sailors.
[89] Reynolds, 15. Mitchell publicly accused leaders from both the Army and the Navy with "virtual murder and treason" for their policies.
[90] Ibid. As a battleship admiral, Moffett initially caused some concern among the aviators, however his skills as a leader and his approach to the problem quickly won them over. BuAer required the direct attention of all the other bureaus – construction, personnel, supplies, engineering, medicine, and ordnance – which made it something of a superbureau within the navy. The bureau was "tightly administered" by Moffett and the CNO and the other bureau chiefs consistently turned to him for advice on aviation issues.

make aviation appear as more a tonic than an irritant to nonaviators."[91] This sentiment is reflected repeatedly in the bureau chief's statements and actions – demonstrating a concern for balance: "I do not desire too much for aviation. I want to keep my feet on the ground when I make statements."[92] He was determined to keep aviation within the navy as an integral part of the fleet, not as a separate corps. Moffett's view of the air arm as inseparable from the fleet owes to his early years in the navy when officers were compartmentalized as engineers, line, or staff.[93]

Moffett skillfully choreographed the development of a core of air minded officers, young and old, and worked hard to ensure a pathway for this new breed of warriors to survive and thrive in the service.[94] Within the bureau, he filled positions with balanced expertise among aviators, engineers, and line officers. Further, he worked tirelessly to nurture relationships and build political capital both in the service and in external constituencies.[95] Moffett proved so adept at building naval aviation within an overall framework of balance and cooperation with the fleet that he was reappointed to the bureau chief position three more times, until a fatal airship accident ended his tenure at twelve years.[96] Luckily, Moffett was not alone.

The portrait of naval air leadership that emerges during this period is much more complex than a single man at the top. Three distinct groups deserve mention here – the "pioneers," the "latecomers," and the old guard "pragmatists." Captain John H. Towers (Naval Aviator No. 3) epitomized the pioneers, men who had been flying naval aircraft since before World War I. Towers aptly administered the Naval Reserve Flying Corps during WWI and became the leader of a tight-knit group of early flyers including, P.N.L

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[91] Felker, 47.
[92] William F. Trimble, *Admiral William A. Moffett: Architect of Naval Aviation* (Washington, D.C.: Smithsonian Institution Press, 1994), 146.
[93] Ibid., 162-3.
[94] Rosen, 76-80. The creation of pathways for advancement of a new class of warriors is an important element in Rosen's theory.
[95] Trimble, 146-163. Also see Rosen, 76-80. As an example, Moffett personally guided the recommendations of the Morrow Board through the legislative process.
[96] Reynolds, 15. Moffett's longevity – more than 12 years guiding the integration of the air arm – is considered an important factor in the ultimate success of carrier aviation. In our interview, historian Williamson Murray also emphasized the importance of longevity. Senior leaders in the military today do not often enjoy the luxury of a long tenure, although they can spend time in a series of related jobs. Additionally, the danger of longevity is keeping someone, unlike Moffett, who acts as a barrier to needed innovation at the helm for an extended period.

Bellinger, George D. Murray, Marc A. Mitscher, and DeWitt C. Ramsey.[97] The latecomers were senior surface officers who became qualified pilots or naval observers in their forties and helped populate the community with "much-needed rank."[98] This group included Joseph Mason Reeves, Harry E. Yarnell, and Frederick J. Horne, as well as Captains Ernest J. King and William F. Halsey, Jr., who would make a distinct mark on naval aviation as well as the course of the Second World War.[99] Finally, among the non-aviators, air-minded pragmatists like Admirals William V. Pratt, Montgomery M. Taylor, and Frank M. Schoefield argued in favor of strengthening naval aviation.[100]

The next key element in this story is experimentation. Once again, stark differences between the British and American experience help illuminate the importance of experimentation. Influenced by the financial troubles of the period, British industry, research and development, and experimentation suffered dramatically before World War II. For example, British aircraft production fell from 30,000 aircraft in 1918 to only 503 aircraft in 1924.[101] Even something seemingly insignificant as the rationing of anti-aircraft ammunition had a deleterious effect:

> Uncertainties and scepticism [sic] were prolonged by cutbacks in research and development. AA ammunition was strictly rationed, for example. This made trials and practices particularly artificial and so allowed the overlong survival of old-fashioned attitudes about AA gunnery, fighter protection, and attack aircraft. This worked to the inevitable benefit of weapons like the battleship, whose value was already established, rather than to unproved aerial alternatives. The shortage of money therefore strengthened the Navy's tendency to play it safe.[102]

In the American case, experimentation proved vital in bringing carrier aviation to the fore. Craig Felker, in *Testing American Sea Power: U.S. Navy Strategic Exercises, 1923-1940*, captures the key role of experimentation in the U.S. Navy's pre-war experience:

> Between 1923 and 1940, the U.S. Navy conducted major fleet exercises designed to allow senior officers to work through strategic issues in an operational setting. The exercises, known as fleet problems, were intended to simulate conditions of a future war. Yet they often reflected an inexact view of the world, vied with political reality, and cast dubious

[97] Ibid., 15-16.
[98] Ibid., 16.
[99] Ibid. Admirals King and Halsey commanded aviation forces in fleet exercise 18, see Felker 57-9.
[100] Ibid.
[101] Till, 197.
[102] Ibid., 190.

> doubts [*sic*] on many of the navy's most cherished principles. Despite these limitations, warfare simulation became an important medium for organizational learning and reform. Operational experiences exposed naval officers to the interdependence between technology and doctrine. Time-honored beliefs on the proper use of naval forces were adapted to accommodate modern weapons.[103]

This is not meant to assert that the U.S. Navy of the period had abandoned all of its deeply held beliefs about war at sea and the role to be played by different platforms – many of the fleet problems only modestly experimented with airplanes and aircraft carriers, and often in strictly limited roles in relationship to the battleship. Despite the several shortcomings, the navy experimented with naval aviation in 15 of 21 exercises during this period, solving many practical problems of operating aircraft at sea.[104]

By the 1930s it was becoming clear to senior naval officers that aircraft carriers had become capital ships in their own right, capable of fighting battleships.[105] The fleet problems had gone a long way in revealing how modern weapons would cooperate with traditional weapons in conducting war at sea.[106] This was a long process, not the result of a singular upheaval as Craig Felker keenly observes:

> Fleet commanders, many of whom had spent their careers in battleships, became less constrained by tradition and more inclined to employ carriers in the role assumed to belong exclusively to the battleship. Pearl Harbor might have made the carrier a de facto replacement for the battleship as the 'backbone of the fleet,' but the fact that within six months of the disaster the navy achieved a significant victory with its carriers at Midway, an engagement commanded by battleship sailor Raymond Spruance, suggests that the seeds for an air navy were sown well before December 7, 1941.[107]

If they did nothing else, the fleet exercises demonstrated that "fleet commanders ignored aviation to their [own] peril."[108]

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[103] Felker, 134. Again, Felker notes that during much of this period the navy remained in port. The annual fleet exercises were the only opportunity to test new equipment and approaches, to include aircraft carriers, submarines, and amphibious assault operations.
[104] Ibid., 34. For a more complete description of each of the fleet exercises, see Felker, 33-60, and Reynolds, 17-20.
[105] Ibid., 56.
[106] Felker, 140. Clearly, the navy's strategic focus led to a better understanding of how the Pacific war would play out than the Atlantic.
[107] Ibid., 141.
[108] Ibid., 35-6.

Results and implications

The British failure to promote innovation and sustain or extend its lead in carrier aviation became clear during the war. The fast carriers that she did possess were pressed into service to protect sea lines of communication. Combating the German U-boat threat required greater numbers, however. This burden increasingly fell on the small, but economical and rapidly produced, escort carriers supplied by American industrial engines from 1943 through the end of the war.[109] Like the close-run Battle of Britain, the nation "very nearly lost the Battle of the Atlantic."[110] Furthermore, British preoccupation with the continent resulted in devastating losses against Japan and the eventual withdrawal of the fleet from Ceylon in 1942.[111]

The success of the American effort now seems a foregone conclusion, though at the time it clearly was not. In the mid-1930s, President Franklin D. Roosevelt began a slow process of naval re-armament. Like their British counterparts, U.S. naval aircraft were markedly inferior to Japanese types; however, unlike the Brits, the U.S. prioritized new aircraft production contracts for the Navy over the Army Air Corps in 1940.[112] Additionally, by 1941 the U.S. Navy had built six fast carriers and two new fast battleships which could keep pace with the carriers.[113] The process was incomplete without the appropriate concept of operations. Unfortunately, though carrier doctrine was flexible, the new ships remained subordinated to the battle line.[114] Events in the early stages of World War II, especially the fact that five battleships were put out of action in the Pearl Harbor raid (notably by aircraft attacking from six fast carriers), as well as the Coral Sea and Midway battles, proved the final arbiter in the outcome.[115] A curious mix of context, culture, and courageous leadership resulted in a success story in military innovation.

With bureau status, a clear indication of the growing importance of the air arm, more favorable economic and security conditions, and congressional concern, the prospects for successfully developing carrier aviation proved much greater for the U.S.

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[109] Reynolds, 3.
[110] Ibid.
[111] Ibid., 3-4.
[112] Ibid., 20.
[113] Ibid. The Navy also had the smaller *Ranger*, CV-4, built in 1934.
[114] Ibid.
[115] Ibid., 21.

Navy than for the RN. Change-oriented leaders, including notable senior leaders throughout the navy, helped transition the air arm from a tiny adjunct to a war-winning mainstay over the course of two decades. Central to this rise was a well-conceived approach to experimentation, which helped solve key tactical and operational challenges, opened the minds of senior sailors to new approaches, and demonstrated the utility of the air arm as an integral part of the naval force.

Chapter 5

The Development of Mechanized Warfare[116]

As always, Cavalry's motto must remain: When better roller skates are made, Cavalry horses will wear them.
Maj Gen John Herr, Chief of Cavalry, U.S. Army, 1942

Tanks, like aircraft, arose from obscurity to become recognized machines of war by the end of World War I. To most observers, the idea that mechanization would be important in future warfare was unquestioned, but the exact role that mechanized forces would play remained open to debate. Like carrier aviation, the British appeared to enjoy several advantages in the development of the new technology; and they similarly failed to derive a workable concept while another nation passed them by – this time Germany.

Britain

The British experience with tanks toward the end of the First World War profoundly shaped the thoughts of all the belligerents in the next war, though in strikingly different ways. Introduced on the battlefield in 1916 to limited effect, it was not until late 1917 that the armored monstrosities heralded a change in how future wars might be waged on the ground. In November 1917, 324 British tanks assaulted the German lines at Cambrai without the traditional preparatory artillery bombardment.[117] Three wedges of tanks, each followed by an infantry platoon, sought to saturate the German defensive line while the British artillery harassed the German batteries.[118] The British attack penetrated the German line by four miles, despite losing more than half the armored vehicles in the first day, many to ditching or mechanical failure.[119] The architect of the

[116] Again, I will use the term mechanized warfare to refer to what is often called *Blitzkrieg* in western writings. For a discussion of historical inquiry and its role in the preparation of military professionals, see Antulio Echevarria II, "The Trouble with History," *Parameters* (Summer 2005): 78-90. Echevarria describes the strengths and weaknesses of historical analysis and concludes that while imperfect, the study of the past is important for developing critical thinking skills and a broad understanding of how warfare has developed.
[117] Theodore Ropp, *War in the Modern World* (New York: Collier, 1959), 298-9.
[118] Ibid.
[119] Ibid. A similar British attack in August 1918 employed 415 tanks and achieved an 8 mile breakthrough, killing or capturing 18,000 soldiers and 400 heavy guns.

Cambrai attack as well as "Plan 1919," a scheme to achieve Allied victory in the coming year was an "abrasive and intolerant" soldier, J.F.C. Fuller.[120] In many ways a brilliant thinker, Fuller has been criticized for glossing over the obstacles that stood in the way of his grand ideas.[121] Regardless, Fuller became perhaps the leading proponent of mechanized warfare in Britain and, along with Captain B. H. Liddell Hart, would most profoundly affect the thinking about mechanized warfare between the World Wars.[122] Despite the most readily transferable wartime experience and the fact that the leading theorists of the tank were British, contextual factors would make the translation of these advantages into a new approach to warfare a difficult proposition.

Once again, the damaging effects of the Great Depression and the resultant "loss of national consensus on military spending" savaged research and development, experimentation, and industry.[123] However, two other developments also played an important role in the British case. First, Britain stood at a strategic cross road, facing a decision on whether its army should serve as an imperial constabulary or a continental force.[124] This question was never satisfactorily resolved either by the political elites or the Chiefs of Staff. Second, at the tactical level, the vulnerability of mechanized machines to antitank fire and subsequent failure of tanks to "make any appreciable impact on the battlefields of the Spanish civil war" seemed to indicate that the tide had turned against the new machines.[125] The combination of strategic and tactical confusion resulted in confused policy prescriptions. The British favored light tanks for their speed (key for surviving an engagement) rather than armor or armament. Additionally, new units were formed without a clear raison d'être, and they were rarely discussed or employed as part of a combined-arms force.[126]

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[120] Hew Strachan, *European Armies and the Conduct of War* (London: Allen & Unwin, 1983), 154-5. Also see Ropp, 268-9. Strachan suggests Fuller was put in the tank corps as a means of getting him out of the way.
[121] Ibid., 270-1. For example, Fuller's "Plan 1919" called for 4300 tanks with 15-18 mile per hour capability and a range of 150 miles – requirements that outstripped the industrial capacity as well as the technical capability that existed at the time.
[122] Liddell Hart proved less a pioneer than a self-promoter compared to the elder Fuller.
[123] Citino, 192.
[124] Ibid.
[125] Ibid.
[126] Ibid. 192-3.

This choice between the slogging, defense-dominant world of the previous war and the armor-enthusiasts' view of the next war as being fought and won by tanks alone, grew primarily from the efforts of J.F.C. Fuller and Basil Liddell Hart.[127] However, despite the apparent technological determinism of their leading theorists, the British did make important strides in mechanized warfare during the period.

Most notably, in 1926 and 1927 the British formed the first totally-mechanized formation in history, the Experimental Mechanized Force (EMF).[128] Fuller was originally selected to command the force, though he was replaced following a pointless argument over his additional duties as garrison commander – a fact that only reminded many of his "arrogance, perhaps even paranoia."[129] The lack of a substantial infantry component in the MEF, while a clear victory for Fuller and like-minded all-tank advocates, proved a significant shortcoming; and the force of tanks and armored cars was disbanded after completing exercises in 1927.[130] In the end, the unit did much to stimulate interest in mechanization both within Britain and abroad, and especially within the German Army who had sent observers to the Salisbury plain.[131]

British experimentation continued in the 1930s, to include several important trials with mechanized vehicles and radios in both 1931 and 1934, also observed by German Army officers.[132] "Though hardly recognized at the time amid all the hubbub about tanks, radio was the real breakthrough of the period…" allowing for the real-time monitoring and direction of the mechanized component.[133] Despite drawbacks, the British program of experimentation proved very modern compared to German exercises of the day.[134] In the end, however, the British never settled on a strategic approach to

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[127] Ibid., 186-90. Fuller and Liddell Hart interpreted the experiences at Cambrai and Amiens to favor minimal infantry among a massive armor force. Citino briefly discusses the relative influence of these two thinkers on pages 186-7. Citino also contends that Liddell Hart, a shameless self-promoter like his German contemporary Guderian, is responsible for promulgating the myth that the prophets of armor and airpower faced powerful "reactionaries of every description" fought against the development of the new weapons, see pages 183-4.
[128] Ibid., 189-90.
[129] Ibid., 190. Fuller claimed his additional duties were intended to ensure the failure of the revolutionary unit.
[130] Ibid., 190-1.
[131] Ibid., 189-91.
[132] Ibid., 191 and 208.
[133] Ibid., 191.
[134] Ibid., 192.

security, nor did they gravitate toward an appropriate combined arms construct to incorporate the new weapons of war.

Germany

While the British floundered, the German Army grappled more successfully with the problem of mechanization during this period. The common perception of how this came about is misleading, however. Just as Liddell Hart promulgated an ego-centric version of events across the channel, Heinz Guderian popularized the *Blitzkrieg* myth, which pitted himself against the status quo forces within the German Army. While an excellent general and tactician, and clearly at least partly responsible for the development of the panzer division, Guderian was one of "dozens of German officers who contributed to the development of German armor" before the outbreak of the Second World War.[135]

Historians Robert Citino and James Corum cite several influential writers and practitioners at the tactical and operational level, including Ernst Volckheim, Oswald Lutz, Alfred von Vallard-Bockelberg, Austrian General Ludwig von Eimannsberger, and Colonel Walter Spannenkrebs, to name just a few.[136] These men wrote and contributed immensely on a wide range of subjects dealing with mechanization and, perhaps more importantly, combined-arms employment.[137] As Citino suggests, "no one man invented it," not even the self-aggrandizing Guderian who made far fewer and much more mundane contributions to the debate.[138] It should also be noted that the German thinkers were much less influenced by Fuller and Liddell Hart as has been suggested. "German tactical writers were, in the main, critical readers who carefully chose concepts – Fuller's and others' – that seemed reasonable and practical and discarded the rest."[139]

Volckheim enjoyed the most extensive experience with tanks during World War I of any German officer. Between the wars he became the most prolific writer on mechanization, authoring dozens of articles and several widely-read books.[140] He also closely followed foreign developments in the field and often read and critiqued the

[135] James S. Corum, *The Roots of Blitzkrieg: Hans von Seeckt and German Military Reform* (Lawrence: University Press of Kansas, 1992), 138-9.
[136] Corum, 126-43, and Citino 196-201.
[137] Ibid.
[138] Citino, 196, and Corum, 139.
[139] Corum, 143.
[140] Ibid., 126-7.

writings on mechanization penned in Great Britain, France, and the United States.[141] Volckheim's judgment proved remarkably prescient, as he correctly gauged the value of heavily armed medium tank over the favored light tanks of the day. He also emphasized the importance of the tank as the primary antitank weapon.[142] His writings illustrate the intellectual growth of the German Army during this period: "In 1923, when Volckheim began writing, most of the articles on mechanized warfare in the *Militär Wochenblatt* were translations or summaries of foreign articles. By 1926 most of the articles on armor and mechanization were written by German officers."[143]

Importantly, these men flourished in a culture that proved more welcoming to dissent than that of its rival armies. First of all, the Germans learned more about fighting tanks during the First World War than any of their adversaries.[144] Perhaps owing to this experience, "All German staff officers assumed the presence of tanks on any modern battlefield and subjected them to a rigorous series of war games, exercises, and maneuvers dwarfing anything done in any of the other nations, with the possible exception of Soviet Russia."[145] Furthermore, the German army enjoyed a long tradition of combined-arms warfare.[146] Finally, the German General Staff tradition ensured armor development would enjoy open and rigorous analysis and debate on its merits.[147]

Contextually, Germany faced a different combination of conditions that helped and hindered the development of mechanized warfare. First and foremost, the harsh provisions of the Versailles Treaty carefully limited the size and weaponry of the German military, with the intent that the vanquished power would be able to maintain only a minimal border guard and internal security forces.[148] Interestingly, as Corum shows, the "*Reichswehr* turned several provisions of the treaty to their advantage," such as the

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[141] Ibid., 129-31. The Truppenamt, the post Versailles incarnation of the old General Staff did a thorough collection and dissemination job relating to foreign armor development.
[142] Ibid., 128.
[143] Ibid., 130.
[144] Ibid., 123.
[145] Citino, 213.
[146] Ibid.
[147] The recreation of the General Staff was strictly forbidden by the Treaty of Versailles. Corum asserts that von Seeckt's greatest accomplishment was preserving the German General Staff construct in the form of the *Truppenamt* and supporting organizations, see page 49. It remained a small and elite organization, in which high caliber officers rotated between the staff and field assignments, with few officers permanently assigned.
[148] Corum, 43. Also see Citino 193-4.

prescribed triangular division structure, lean and efficient headquarters, and a large and competent non-commissioned officer (NCO) corps.[149] "Versailles, though an inconvenience, did not prevent the Germans from studying armored warfare, writing about it, or even training for it."[150] Some of this was done secretly, though it became increasingly overt as Germany remilitarized in the 1930s.

Geography too played a central role in the development of mechanized warfare. "Because of Germany's unfavorable geographic position in the center of Europe, the German general officer corps was always trying to conduct so-called quick wars to force an immediate operational decision."[151] Certainly, the German strategic situation, surrounded by potential adversaries and lacking any significant strategic depth, contributed to a world view that would favor mechanization and a return to the primacy of the attack. Of all the contextual factors, perhaps the nation's biggest challenge lay in the overall inadequacy of industrial capacity.[152] Economic crisis following the First World War, diminished demand in the 1920s, and raw materials shortages resulted in a shrinking arms-production sector. Further, one of the lessons from the Great War was the importance of industrial capacity as an arbiter of victory.[153] This weakness would need to be addressed if Germany again became involved in total war on the continent.[154]

Fortuitously, an able and thoughtful leader emerged to shape the interwar German army, Hans von Seeckt. A highly-regarded General Staff officer, like Britain's Fuller, von Seeckt enjoyed a formative experience as a planner in the First World War as the Chief of Staff during the 11th Army's offensive in Galicia in May 1915.[155] In one of the greatest German victories of the war, the 11th Army broke through the Russian line at Gorlice following a short intensive bombardment and instead of turning to envelope their

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[149] Corum, 43-4. The treaty limited officers as well as the overall size of German forces, but it did not address the strength of the NCO corps. This loophole allowed the Germans to build a strong NCO backbone, and NCOs often performed many of the tasks that officers would be required to perform in other armies. The triangular division structure was already considered to be superior by the General Staff, but it was not yet in vogue in other European armies.
[150] Corum, 125.
[151] Freiser, 9.
[152] Strachan, 161-2.
[153] Ibid., 150.
[154] This concern was shared by members of the high command and reportedly even German Chancellor Adolf Hitler on the eve of the Second World War. Hitler's miscalculation of the strategic situation and the resolve of the European powers brought war to Germany far too soon – and her raw materials and industrial capacity shortfalls proved catastrophic.
[155] Corum, 25-8.

foe, advanced more than 80 miles in twelve days.[156] By the end of June, all of Galicia and its 400,000 defenders had fallen to the Germans.[157]

After the war, von Seeckt served as the General Staff representative to the Peace Conference at Versailles before ascending to the top post in the army.[158] Von Seeckt saw mobility as the key to victory in future war; but unlike most veterans, he proved remarkably immune to the accepted lessons of WWI.[159] Early in his tenure, he formed 57 committees and sub-committees to study all facets of the recent wartime experience.[160] He sought the brightest officers with the right experiences and specialties:

> [O]ver 500 of the most experienced German officers were involved in a program to mold their war experiences into a system of modern tactics and military organization. The victorious nations also rewrote their tactics, but neither the British, nor the French, nor the Americans approached the study of the war in so comprehensive a manner or employed the efforts of so many of their best officers as the Germans did.[161]

The resulting army regulations from the 1920s "emphasized all of the principles necessary to conduct a war of movement: the offensive, combined arms, maneuver, independent action by officers, and intelligent effective leadership at all levels."[162] Von Seeckt's approach was ultimately accepted by the Reichswehr, "but only after considerable opposition and debate."[163]

The theoretical foundation of combined-arms mechanized warfare was augmented by a robust experimentations program. "Since the days of the elder Moltke, the German army had relied on exercises, war games, and maneuvers as a means of training its officers and testing its doctrine."[164] This tradition continued under von Seeckt, who insisted that tanks be represented to the maximum extent.[165] In some cases, this required the construction of full-scale mock-ups of French and British designs – and it also led to

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[156] Ibid., 27.
[157] Ibid.
[158] Ibid., 29,
[159] Citino, 194 and Corum, 129-30. Citino contrasts von Seeckt's combined arms approach with the one dimensional solution favored by "tank fiend" J.F.C. Fuller in Britain.
[160] Corum, 37-8.
[161] Ibid., 38-9. In Britain, by comparison, B.H. Liddell Hart, then a Lieutenant with limited wartime experience, was tabbed to rewrite the infantry tactical manual. A solid but incomplete effort, army leaders replaced an objectionable chapter with a chapter from the obsolete 1911 volume.
[162] Ibid., 48.
[163] Ibid., 50.
[164] Citino, 202.
[165] Corum, 133-4.

secret development and exercises with Russian cooperation.[166] Exercise after exercise introduced mechanization to the field, but it wasn't until 1937 that the majority of officers came to regard the panzer division as a superior approach.[167] And not until 1940 did the "operational employment of armor" appear in the regulations.[168] Moreover, German officers also traveled extensively and benefited greatly from the mechanization debates and experiments throughout Europe. They were clearly impressed with British exercises that integrated radio communications with vehicles in 1931 and 1934, as well as the scale of mechanization achieved by the Red Army in its 1936 maneuvers.[169]

Results and implications

Though not presented in depth here, the U.S. Army's experience with mechanized warfare in the interwar period also came up short of the German ideal. David Johnson, in his excellent work on the subject, cites tight budgets, an isolationist congress, and an unprepared army that would not tolerate debate and dissent as the key reasons for the failure.[170] Also prominent in his analysis was the inter-service dispute between airmen and soldiers, which contributed to the lack of a coherent combined-arms approach to the problem.[171] In both Great Britain and the United States, the powerful strategic bombing advocates dominated the development of airpower during the period; this was not the case in Germany where the Luftwaffe concentrated much more on ground-support functions.[172] However, powerful infantry and cavalry branch chiefs also contributed mightily to the failure, overseeing a culture that repressed officers who advocated a broader role for tanks – a culture that did not value dissent or even the kind of limited

[166] Ibid. Also see Freiser, 38.
[167] Citino, 202-7.
[168] Freiser, 33.
[169] Citino, 208-11. Also see Strachan, 158-61, for a discussion of mechanization in Soviet Russia. Russia enjoyed perhaps the most advanced capability to conduct mechanized warfare in 1936, however ill conceived lessons from the Spanish Civil War coupled with Stalin's "domestic jealousies" and the subsequent purges prevented the Soviets from realizing the gains from their interwar efforts.
[170] Johnson, 229.
[171] Ibid., 226. It should be noted that many problems on paper were resolved in the conduct of the war by soldiers and airmen, most notably General George Patton and his air commander in France, General Otto P. Weyland, and in the Pacific, Gen Douglas MacArthur and his airman General George C. Kenney.
[172] Strachan, 162-3. Strachan provides a concise summary of the development of mechanized warfare in all the major belligerents in chapter 10.

self-analysis in its professional school system that might have made a difference.[173] As a case in point, Dwight D. Eisenhower "was rebuked by the U.S. Army's chief of infantry after having advocated a stronger tank force for infantry divisions and then was threatened with a court-martial if he continued publishing in that vein."[174]

Surprisingly, only 16 of 157 German divisions that invaded France in 1940 were fully mechanized, and those early *panzers* were inferior to French designs at the time.[175] The Polish campaign eight months earlier had served as a kind of "proving ground," as never before had an exercise of that scale been attempted.[176] Further, in those eight months, the German army undertook an unparalleled "training offensive" designed to prepare commanders and their units for the operational and tactical problems they would face in the future.[177]

Some critics suggest that the actual course of events resulted more from the German ability to improvise a solution that best fit the prevailing conditions.[178] The striking German successes in Poland in September 1939 and in France in the summer of 1940, though clearly not entirely the result of the perfection of an new way of warfare, demonstrated that the German Army did a better job at thinking about, developing, and testing a coherent combined-arms approach to meet the realities of combat at the outbreak of the Second World War.[179] This was in part due to different circumstances and in part to change-oriented leaders at several different strata who operated in a culture that was open to dissent.

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[173] Johnson, 222-5. Johnson describes the school system as one that focused on accepted doctrine and able practitioners and did not cultivate broader thought, particularly on how new means of warfare might change the way wars were to be fought in the future.
[174] Corum, 141. There is no similar anecdote in the German army of the period, illustrating the difference in the tolerance for debate between the two armies.
[175] Freiser, 29 and 37. Lack of rubber and steel was a primary reason behind limited mechanization.
[176] Ibid., 19.
[177] Ibid., 24. The German training sharply contrasted with French preparations during the same period.
[178] Ibid., 34.
[179] Ibid., 346-8. Freiser argues that three primary factors contributed to 1940 success: the pendulum of martial technology now swung in favor of the attacker (*Panzer* & *Luftwaffe*), traditional German command principles (e.g. *Auftragstaktik*, which is commonly characterized in the West as mission type orders given by the superior and initiative on the part of the subordinate commander) enhanced in undreamed of ways, and the Germans proved much quicker at adapting to new situations (less inhibited, such as in the case of Guderian's unauthorized breakout a Sedan).

Chapter 6

Analysis

> *Intellectual agility is the ability to allow yourself to fully understand, appreciate, adapt to and integrate others' ideas and ways of thinking with your own, and, on occasion to abandon your own preconceptions quickly and entirely when presented with compelling evidence of a better answer.*
>
> Dave Pollard[180]

In the fight to develop innovative solutions to the challenges it faces, the U.S. Air Force enjoys several advantages and disadvantages. The Service is still relatively young, less bounded by deep tradition and precedent, and technologically based – indeed the Air Force was founded on the innovation of manned flight and the belief that it brought a distinct advantage to the centuries-old practice of war. Airmen have long been receptive to new and especially technical solutions to problems, and the Service has well-established links to research and industry, as necessitated by its reliance on aerial platforms and their associated weapons, communications, and sensor sub-systems.

Disadvantages include a high degree of association with a particular sub-branch or platform; such as primary identification as a fighter pilot or an airlifter. This carries with it a preference for technologies and concepts that follow along the same trajectory. Furthermore, the advantage of youth can also be a disadvantage if the service has not grappled with a series of revolutionary changes in the same way that other services have (from sail to steam to subs or from cavalry horses to cavalry tanks to cavalry helicopters, for example). The Service has also earned a reputation, albeit not a completely accurate reputation, as one that eschews the rigorous study of warfare. A more accurate description would emphasize the need for its practitioners, heretofore primarily pilots of manned aircraft, to spend much more time in the pursuit and maintenance of the technical skill of flying than gaining practical experience and studying the management of violence compared to other services. Flying officers are the predominant combat practitioners in

[180] Dave Pollard, "How We Can Improve Collaboration," 22 Nov 04 [on-line]; available from http://blogs.salon.com/0002007/2004/11/22.html; Internet; accessed15 October 08.

the service, and their unique skills of linking man and machine to achieve results are supremely perishable.

Hypotheses revisited

The evidence from the previous two chapters supports the four working hypotheses offered in chapter 3. First, context matters most. Self styled strategist Colin Gray has commented that "the authority of context is a big idea that we neglect at our peril."[181] He lists seven subordinate contexts that collide to produce outcomes: political, social-cultural, economic, military-strategic, technological, geographical, and historical.[182] In Britain for example, economic stringency, geography, and the military strategic concerns of the German threat combined to impede the development of carrier aviation. In contrast, in the United States the development of carrier aviation was aided by geographic realities, the military-strategic situation, and the political climate of the interwar airpower debates. Contextual factors similarly affected the development of mechanized warfare during this same period – with different combinations affecting different belligerents in unique ways.

I would add one subordinate idea to this first hypothesis – the paramount importance of how a nation or a military service characterizes the grand challenge. In the United States, for example, the navy seized upon the idea of Japan as the next strategic competitor, fueling carrier aviation. Germany saw mobility as an answer to her unique geographic position in Europe and the challenges of industrial capacity, rather than the ponderous, defensive warfare of 1914-1918. The conclusion that leaders arrive at after they break down facts and re-assemble them in the form of a grand challenge that must be overcome appears to weigh heavily on the success or failure of a particular innovation.

Second, the organization's culture must tolerate debate and accept the challenge of change. In both successful cases examined here, the American development of carrier aviation and the German development of mechanized warfare, the parent organizations proved open to debate when faced with a new approach to warfare. Certainly, healthy skepticism existed within each organization; but debate flourished and both were willing to challenge existing notions if it would result in an improvement in warfighting ability.

[181] Colin S. Gray, "The 21st Century Security Environment and the Future of War," *Parameters* (Winter 2008-9): 18.
[182] Ibid., 18-9.

Two subsequent observations deserve mention here. The growth of military airpower after the First World War, and the subsequent debates about the roles and relative importance of airpower in relation to traditional military domains affected all the cases studied. In Britain, the strategic airpower arguments carried the day and resulted in the RAF gaining prioritization in resources over RN aviation. Similarly, within the United States, airpower debates fundamentally affected the successful outcome in the case of naval aviation and the failed outcome in the case of mechanized warfare. This leads to the observation that in both the U.S. Navy and the German Army, an evolutionary combined-arms approach was more readily apparent than in the failed cases. This area deserves further study – whether success was due to an evolutionary approach or whether this was just coincident to these two cases. Some have argued that disguising innovation or subordinating it to existing warfighting means is needed to succeed. Perhaps this is because the full weight of an organization can get behind the effort and better understand the change in the long run if it does not see the threat of a revolutionary change.

Third, politically-adept, change-oriented leaders must emerge at multiple strata within the organization. It is easy to look back at historical cases and identify the singular person who is responsible for success or failure. There is no doubt that Hans von Seeckt or William Moffett proved instrumental to the ultimate success of the respective innovations they shepherded. However, historical emphasis on the man at the top obscures the very real and very important contributions of many, some of whom may have been irreplaceable at least in the time frame considered.

Take for example the launch of an aircraft at sea. U.S. Navy Captain Henry C. Mustin, considered "the Father of Naval Aviation," was the principal architect of the ship-board-catapult concept. He also made the first successful catapult launch from an underway ship in 1915. But even this feat was the result of cohort of contributors. Samuel Langley had previously used a spring catapult system to launch model aircraft, and the Wright brothers employed a weight-and-derrick style catapult to assist their early designs with takeoff when space was limited. Four years before Mustin's launch, Naval Aviator #1, Lieutenant T. G. Ellyson failed in a compressed air catapult launch of his Curtiss A-1 *Triad* due to crosswinds. Later that year, Ellyson was successful in a launch

from the Washington Naval Yard. In the development of the catapult launch, like the other cases reviewed here, success had many fathers.

Fourth, rigorous experimentation to solve problems and demonstrate the utility of the change is paramount. The catapult anecdote also illustrates how experimentation can play an important role in success. First of all, each of the innovations studied faced a series of tactical and operational problems that had to be overcome: the launch and recovery of aircraft from a moving ship, night flying at sea, aircraft operations in adverse sea states, over-water navigation, to name just a few from the development of carrier aviation. In the case of mechanized warfare, command and control, ultimately realized through the use of the radio, serves as the most obvious example. In each case, technology and tactics had to go through a series of sustaining innovations to make them viable tools for the warfighter.

Perhaps more importantly, rigorous experimentation in the case of U.S. naval aviation and in the case of the German *Panzer* forces was needed to demonstrate how these new tools and approaches could enhance the ability to wage war. Traditionalists in the military have always been concerned that the pace of change might unwittingly place the lives of soldiers, sailors, and airmen at risk in the form of an untested doctrine or piece of military hardware. The annual fleet exercises and the German mechanization experiments went a long way in demonstrating to skeptics that these innovations would be vital to future battles.

One final observation becomes apparent after reviewing the final two hypotheses. In both positive cases, change was generational, that is it took several decades before success was realized. [183] This appears to be in part due to the need to grow leaders and adherents in the ranks as well as to solve problems and demonstrate utility through experimentation.[184] The generational pace of innovation carries greater significance today, given the accelerated rate of technological change.

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[183] See John P. Kotter, "Leading Change: Why Transformation Efforts Fail," *Harvard Business Review* 73 (Mar 95): 59. The author provides several lessons from watching more than 100 companies try to remake themselves over a decade long period. Kotter asserts that change does indeed take a long time and that skipping a step only creates the illusion of speed.

[184] Ibid. Kotter emphasizes the need to take time and to ensure that the next generation of top management personifies the new approach rather than that of the old guard.

Implications

If the four working hypotheses presented above are accurate, several implications for Air Force leaders follow from them. First, leaders must first be aware of and manipulate contextual factors when possible. They must track trends, understand how the different contextual domains merge and interact, and try to cultivate those factors that serve as an advantage while trying to suppress those that act as barriers to the innovation sought.[185] Acknowledging that this may most likely require a generation-long effort, leaders must remake and iteratively revise their assumptions as context changes.

Today, the United States faces a severe economic downturn, one that has global effects and consequences. Economic pressures have already shown signs of upsetting defense spending and long-term procurement plans. The United States also finds itself facing a strategic situation that more closely parallels the British strategic situation before the outbreak of World War II. Geographically, the two vast oceans on either coast no longer insulate the nation from foreign disturbances as they once did. Finally, the pace of technological change has increased, and the scope has expanded into new areas such as nanotechnology and synthetic biology. How well will the Air Force manage innovation in this context?

Second, leaders must foster a culture that tolerates dissent. "The most critical variable for reform… may be its ability to tolerate dissent and balance such dissent with the ever-present requirement for discipline and obedience, which is the sine qua non of effective combat performance."[186] According to Clayton Christensen, culture allows an organization to act autonomously and consistently.[187] If the organization approaches dissent and debate on fundamental changes to the way it fights in a thoughtful and consistent way, then individuals will be more apt to think and act in innovative ways. This is an exceedingly difficult process that demands "ruthless intellectual honesty and critical self-examination and is usually accompanied by a significant amount of internal debate."[188]

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[185] "Contextual domains" refers to Colin Gray's seven subordinate contexts: political, social-cultural, economic, military-strategic, technological, geographical, and historical, see Gray, *Parameters*, 18.
[186] Winton, xiv.
[187] Christensen, *Innovators Solution*, 189.
[188] Winton, xii.

Can long-standing and deeply-held beliefs, assumptions, and processes be challenged, and by whom? And what is the best way to debate how an innovation might change the way the Air force fights? Traditionalists would point to the war colleges and other military schools and their associated curricula, or to the offerings found in the several scholarly and service journals that cater to defense issues for an answer here. But society sits on the verge of a technological awakening in education and training – the means for delivering information or debating alternatives is not confined to brick-and-mortar schools or the printed word. The Air Force should invest time and effort in understanding how web-enabled services – list servers, bulletin boards, chat rooms, social networking tools, and the like can enable a culture of reasoned dissent to flourish. These same tools can also be used to educate officers on key technologies, scientific discoveries, and other developments to help close the scientist-layman gap that makes modern technologies impenetrable to many.

To assist this process, the Air Force must define a value proposition that reinforces the drive to innovate. This is indeed treacherous ground – for it conjures up past arguments about mission statements or relative importance of subordinate components within the service. This kind of debate misses the mark. Rather than specific capabilities embedded in particular weapon systems, this value proposition should unite the diverse communities of practice and tribes that make up today's Air Force. It should expose the essence of what the Air Force brings to the national security table, not merely the activities it performs. Stephen Downes' story of former typewriter giant Smith-Corona provides an intellectual starting point for this discussion:

> Remember Smith-Corona. When the plant closed, the president said, "This (the last typewriter) is the best product we have ever produced. But what we ended up doing is perfecting the irrelevant."
>
> And very many groups can be in this process. They confuse activities and value proposition. Ask Smith-Corona. They thought they were in the typewriter business. But that was merely their activity. Their value proposition was helping people do word processing…. If you confuse activities and value propositions, you are destined to be annihilated.[189]

[189] Stephen Downes, "Creative Destruction and Disruptive Innovation," 11 Nov 2003 [on-line]; available from http://www.downes.ca/cgi-bin/page.cgi?post=51; Internet; accessed 3 November 2008. The company declared bankruptcy and moved its typewriter manufacturing operations from Cortland, NY to Mexico in 1995. Smith Corona ceased manufacturing in late 1997 and transitioned into a sales and marketing

Furthermore, the value proposition of an innovation should align with the value proposition of the service.

I will not be so bold to suggest that the Air Force does not understand its value proposition, or to opine that "Fly, fight, and win" is inappropriate or somehow lacking. However, I do suggest that the service look at this idea of a value proposition: What intrinsic value does it bring to national security? Answering this question will ensure it has established a firm foundation for innovation.

Third, leaders must identify and prepare other innovative leaders throughout the organization. This sounds deceptively simple – ideally it is the blueprint for a generic talent-development effort. But implementing this type of approach might require the service to fundamentally alter existing paradigms and processes for promotions and assignments. This has been done before, most recently through adherence to the Goldwater-Nichols provisions that placed an emphasis on joint-officer development.

Clayton Christensen's work on innovation in business led him to conclude that companies often select leaders for certain positions based on measures of past performance; past success was seen as an indicator of potential for success in future endeavors. This is arguably similar to how a service promotes its officers. However, Christensen's research led him to conclude that the better indicator of success at meeting a challenge was not past performance but instead exposure to a similar problem and context, regardless of outcome in the past:

> In order to be confident that managers have developed the skills required to succeed at a new assignment, one should examine the sorts of problems they have wrestled with in the past. It is not as important that managers have succeeded with the problem as it is for them to have wrestled with it and developed the skills and intuition for how to meet the challenge successfully the next time around. One problem with predicting future success from past success is that managers can succeed for reasons not of their own making – and we often learn far more from our failures than our successes.[190]

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organization. Since 1995, the company has concentrated on sales of portable electronic typewriters, as well as typewriter and word processor supplies. The company's current electronic models feature LCD displays, built-in dictionaries, and spell- and grammar-check features.

[190] Christensen, *Innovator's Solution*, 180.

Christensen argues for an experiential approach to leader selection, especially in the case of rare disruptive innovations, ideas or approaches that challenge the established processes or values of the organization.[191] This can prove more challenging in a hierarchical bureaucracy because bureaucracies are built on enduring processes. "When the capabilities have come to reside in processes and values and especially when they have become embedded in culture, change can become extraordinarily difficult."[192] Part of the challenge then is balancing the demand for fully-qualified or experienced leaders with the imperative to develop innovative leaders who have experience gaps.

This discussion begs the question, "Are leaders born or made?" What intrinsic abilities did a William Moffett have that fostered innovation? What component was experiential and what was learned through training or education? How are these characteristics and experiences measured? And, given the first conclusion we reached, which of these capabilities transfer from one context to another? Amy Edmondson argues for "performance increasingly determined by factors that can't be overseen: intelligent experimentation, ingenuity, interpersonal skills, resilience in the face of adversity, for instance."[193] Can these attributes be consistently measured and evaluated? Finally, how does the service ensure that their Moffett arrives at the helm of the right organization at the right time to bring about the needed change?

I suspect there is no easy or consistent answer to any of these questions. Perhaps the best that can be hoped for is that the Air Force can build a stable of innovative leaders with diverse experiences and backgrounds – a degree of planned randomness perhaps. This may require the service to characterize experiences, to include what leaders or mentors someone has been exposed to, and the context – not just the results of their experiences. A fundamental tension exists here between placing an individual in a specific billet to fill an experience gap and placing someone else because he has the right experience in his past to indicate he would succeed at the challenge posed by the new assignment.

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[191] Ibid., 189. According to Christensen, few leader shave experience dealing with disruptive innovations. Furthermore, in these rare instances, existing organizational processes and leadership practices are ill suited to succeed.
[192] Ibid.
[193] Amy C. Edmondson, "The Competitive Imperative of Learning," *Harvard Business Review* 86 (Jul-Aug 2008): 61-2.

Fourth, leaders must emplace a rigorous and systemic process for experimentation. Together, wargaming, simulation, and experimentation will be bedrocks for success in future innovation, provided they do not approach the problem with a pre-ordained answer. As the case studies demonstrated, rigorous experimentation served two ends – solving tactical and operational problems confronting the innovation, and demonstrating the utility of the innovation to skeptics internal and external to the service. These two ends, however, can sometimes act in competition with one another. Success in a carefully-managed and limited experiment may convert more adherents, raise the energy and effort of the group, and gain influential supporters. This may not be the best model for a problem-solving approach that may see many failures and identify new problems to solve.

Unfortunately, several observers that I interviewed pointed out the absence of meaningful experimentation like the pre-World War II cases described herein in the current Department of Defense. Perhaps it is because failure can quickly end support for a particular innovation. It has also become exceedingly difficult given a decline in real numbers of people and machines and an increase in operational tempo for those who remain to obligate forces to a lengthy and robust experimentation program. Other scholars have observed that testing innovations can be difficult in peacetime.[194]

Future wargaming is another area where this is evident. At the time of this writing, the Air Force is the only service that continues to conduct a futures game, which it does every other year. The absence of future games prompted the Office of Net Assessment to resume its series of 20XX games and workshops. These types of games are important to begin to socialize new ideas about the conduct of warfare and to establish a baseline understanding of the kinds of technologies and tactics that might be available for the next generation of military professionals.

Clearly, the Air Force has a lot to consider in how it approaches innovation and the development of leaders to promote innovation. This is especially important now that

[194] Showalter, 232. The Director of Net Assessment, Mr. Andy Marshall, remarked in his interview that robust experimentation (on par with the kind of experimentation that took place between the wars) with the aim of refining innovative approaches to the challenges we faced was one element which continued to elude the Department of Defense.

available technologies can enable a new paradigm for education and training.[195] A long-time observer of the service's professional military education programs, retired Colonel Dennis Drew has offered several recommendations for improving how the Air Force conducts these programs.[196] Drew's approach calls for a reconstruction of the resident and non-resident versions of PME to provide a rigorous, career long, warfighting focused development program. A diverse group of scholars and practitioners support this call for education reform, from Congressman Ike Skelton to Douglas Macgregor, to name two.[197]

While some of Drew's prescriptions would admittedly prove controversial, on their totality they deserve careful consideration. One of his primary assertions, however, should not be met with criticism, that "personal professional, intellectual development must become a requirement of every officer."[198] (The Appendix to this paper offers a suggested self-study program that can serve as a staring point.) Drew is not alone in calling for the purposeful self-study within the officer corps.[199] Furthermore, self-study and improvement must be rewarded as a component of professional competence, the bedrock of our personnel system today. Providing the right kind of experiences, training, and education to grow innovative airmen is critical if the service wants to build the kind of innovation engines that brought carrier aviation and mechanized warfare to the fore between the two World Wars.

Concluding Remarks

Innovative thinking must remain a hallmark trait of the United States military, the services and the broader defense institution as a whole. As the cases examined above suggest, contextual factors can dominant choices to a great extent. However, ignoring the powerful impact of the right leader who can shape context and culture to the advantage of

[195] Singer, 218. Singer points out how our "backward" adversaries are harnessing modern technologies in the improvised explosive device cat and mouse game: "Illustrating their technical savvy, the insurgents then spread the word on how to make these weapons in instructional DVDs and postings on the internet."
[196] See Dennis M. Drew, "Educating Air Force Officers: Observations after 20 Years at air University," in *Recapitalizing the Air force Intellect: Essays on War, Airpower, and Military Education* (Maxwell AFB, Al: AU Press, 2008): 211-22.
[197] See Ike Skelton, "Beyond Iraq," Remarks of Congressman Ike Skelton to the Dwight D. Eisenhower National Security Conference, 28 Sep 2005, and Macgregor, 210-5.
[198] Ibid., 218. "The dilemma is that we need to reshape our culture without destroying the traditions that have served us well in the past. Somehow we must make it culturally acceptable and professionally imperative to be air warriors well schooled in the theory, doctrine, and history of aerial warfare." Further, Drew believes this a requirement of every officer, regardless of specialty or rank.
[199] Again, see Skelton and Macgregor, 214.

innovation is short sighted. The study of innovation can and should be an important component of the individual and the institutional development of the professional officer corps of a service. Furthermore, breaking free from parochial perspectives and preferred operational challenges and approaches may often prove uncomfortable, indeed at times almost counterproductive to a particular career.

> *However praiseworthy it may be to uphold tradition in the field of soldierly ethics, it is to be resisted in the field of military command. For today it is not only the business of commanders to think up new techniques which will destroy the value of the old; the potentialities of warfare are themselves being continually changed by technical advance. Thus the modern army commander must free himself from routine methods and show a comprehensive grasp of technical matters, for he must be in a position continually to adapt his ideas of warfare to the facts and possibilities of the moment. If circumstances require it, he must be able to turn the whole structure of his thinking inside out.*[200]

Given the immense challenges of the future security environment, a failure to effectively think about and implement innovative solutions will yield a precipitous decline in our ability to influence outcomes.

[200] Attributed to Field Marshall Erwin Rommel.

Appendix

Suggested Self Study in Innovation

Individual airmen must build a broad foundation in the study of warfare. While this foundation should be provided during professional military education (PME), it can and should be supplemented throughout the officer's career. In addition to regularly reading on current military operations and events, I offer the following suggestions as a starting point, realizing that many valuable works will be neglected or overlooked:

Warfare and strategy in General

1. *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, edited by Peter Paret. The most recognized modern interpreter of Clausewitz, Peret's survey of strategic thinkers is a must read – the absence of eastern thinkers is a lone weakness.
2. *Some Principles of Maritime Strategy* by Julian Corbett, Part I, chapters 1-3. In this opening section, Corbett provides a concise and eminently readable interpretation of Clausewitzian theory.
3. *The Landmark Thucydides* edited by Robert Strassler. The most widely acclaimed and enduring portrait of human/societal motivations and interactions. Marginalia as well as online study guides to focus on key dialogs prove helpful.
4. *War in European History* by Michael Howard. A quick read covering warfare in Europe from the Middle Ages through the nuclear age.
5. *Why the Allies Won* by Richard Overy. A comprehensive single volume history of the Second World War.
6. Antulio Echevarria II, "The Trouble with History," *Parameters* (Summer 2005): 78-90. A short but provoking piece on how military professionals should view history.

Awareness and decision making

1. *The Bureaucratic Entrepreneur: How to be Effective in an Unruly Organization* by Richard Haass. Hass' provides a valuable framework for assessing the environment as well the interests of your superiors, subordinates, peers, and outside influencers.
2. *Essence of Decision: Explaining the Cuban Missile Crisis* by Graham Allison and Philip Zelikow. Introduces different explanatory models of decision making.

3. *Thinking In Time: The Uses of History for Decision Makers* by Richard E. Neustadt and Ernest R. May. Practical suggestions for using historical cases in policy making.
4. *Agendas, Alternatives, and Public Policies* by John Kingdon. Kingdon concisely describes the players and processes that shape public policy formulation in the U.S.
5. *Strategic Assessment in War* by Scott Sigusmund Gartner. Gartner's analysis of dominant indicators helps shed light on how different communities or groups of practitioners interpret the success or failure of policy choices.

Airpower and airpower strategy

1. *The Paths of Heaven: The Evolution of Airpower Theory*, edited by Phillip Meilinger. The equivalent of *Maker's of Modern Strategy* for airpower theory. Similarly, Bruce DeBlois' provides a compilation of space power theory in *Beyond the Paths of Heaven: The Emergence of Space Power Thought.*
2. *Air Warfare in the Missile Age* by Lon Nordeen. A survey text that examines air warfare from Vietnam through the early days of the Afghanistan campaign in 2001.
3. *The Transformation of American Air Power* by Benjamin S. Lambeth. Lambeth looks at the "non-linear" airpower evolution from Vietnam through the Balkan conflict of the 1990s.
4. *Case Studies in the Achievement of Air Superiority* edited by Benjamin Franklin Cooling. Other volumes in the series include *Case Studies in Close Air Support* and *Case Studies in Strategic Bombardment.*
5. *Airpower in Small Wars: Fighting Insurgents and Terrorists* by James Corum and Wray Johnson. Airpower employment in small wars during the twentieth century.

Innovation

1. *Winning the Next War* by Stephen Peter Rosen. A conflict relationship approach to the study of military innovation.
2. *War Made New* by Max Boot. An historical look at military innovation over 4000 years with some enduring lessons for practitioners.
3. *The Innovator's Dilemma* or *The Innovator's Solution* by Clayton Christensen. Business focused, but Christensen's works should prove thought provoking, particularly for the innovator in an established business or bureaucracy.
4. *Pick a subject matter: carriers, mechanized warfare, airland battle, precision guided munitions, global positioning system, intercontinental ballistic missiles, tomahawk, etc.* Read a variety of biographical and survey works on the innovation.

5. *Profiles of the Future* by Arthur C. Clarke. The science fiction giant sheds light on how to understand trends and to make more reliable characterizations of the future.
6. *Wired for War* by Peter Singer. A comprehensive examination of robotics and how it affects warfare today and in the future.
7. DARPA Strategic Plan, available to the public from the DARPA website at www.darpa.mil. The plan provides an overview of DARPA, its approach to innovation, and some of the ongoing work it is engaged in.

Non-Traditional Sources – Modern media applications provide a variety of information tools that can be tailored to a specific need. From blogs to listservs, these sources may be administered by news media, industry, organizations, or even informal social networks. For example, the *ARES Defense Technology Blog* administered by Aviation Week.[201] Other examples include *The Early Bird* news service, *Danger Room*, and NTI's *Global Security Newswire*.

[201] See http://www.aviationweek.com/aw/blogs/defense/index.jsp.

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